

## Inventory and analysis of the distribution of Viséan corals from the Guadiato Area (Córdoba, SW Spain)

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### ABSTRACT

The coral content of the Viséan rocks from the Guadiato Area (SW Spain) have been studied during the last 25 years. Part of the coral assemblages have been previously described, but never as whole. The 69 recorded coral species belonging to Rugosa, Tabulata and Heterocorallia are illustrated. The family Antiphyllidae is represented by two genera and three species; the family Laccophyllidae is represented by one species; the family Cyathaxoniidae is represented by one genus and two species; the family Amplexidae is represented by one species; the family Zaphrentoididae is represented by one species; the family Plerophyllidae is represented by one species; the family Polycoliidae is represented by one species; the family Pentaphyllidae is represented by one species; the family Cyathopsidae is represented by four genera and five species; the family Bothrophyllidae is represented by one species, the family Aulophyllidae is represented by nine genera and ten species; the family Palaeosmiliidae is represented by four genera and four species; the family

### RESUMEN

El registro de corales fósiles del Viseense del Área del Guadiato (SO de España) ha sido estudiado durante los últimos 25 años. Parte de las asociaciones de corales habían sido previamente descritas, nunca en su conjunto. Se figuran las 69 especies registradas pertenecientes a Rugosa, Tabulata y Heterocorallia. La familia Antiphyllidae está representada por dos géneros y tres especies; la familia Laccophyllidae está representada por una especie; la familia Cyathaxoniidae está representada por un género y dos especies; la familia Amplexidae está representada por una especie; la familia Zaphrentoididae está representada por una especie; la familia Plerophyllidae está representada por una especie; la familia Polycoliidae está representada por una especie; la familia Pentaphyllidae está representada por una especie; la familia Cyathopsidae está representada por cuatro generos y cinco especies; la familia Bothrophyllidae está representada por una especie; la familia Aulophyllidae está representada por nueve géneros y diez especies; la familia Palaeosmiliidae

Lithostrotionidae is represented by five genera and sixteen species; the family Axophyllidae is represented by three genera and thirteen species; the family Geyerophyllidae is represented by one species; the family Heterophyllidae is represented by two genera and two species; the family Syringoporidae is represented by one species; the family Multithecoporidae is represented by one genus and three species; the family Syringolitidae is represented by one species; the family Pyrgiidae is represented by one species. The degree of abundance and diversity is regarded as moderate and the degree of endemism is low. The significance of the coral assemblages for biostratigraphy, palaeobiogeography and environmental palaeontology is analysed.

**Keywords:** Guadiato Area, Ossa-Morena, Mississippian, Carboniferous, Rugosa.

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**Palabras clave:** Área del Guadiato, Ossa-Morena, Misisípico, Carbonífero, Rugosa.

## 1. INTRODUCTION

The Guadiato Area (Córdoba Province, SW Spain) is located in a region between the Ossa-Morena and the Centroibérica zones (Chacón *et al.*, 1974; Delgado-Quesada *et al.*, 1977; Apalategui *et al.*, 1985; Gabaldón *et al.*, 1985a, b), that has been also called the Lusitan-Marianic Zone (San José *et al.*, 2004). Carboniferous rocks ranging in age from Viséan to Moscovian occur in the region. The Mississippian rocks are mainly marine, whereas the Pennsylvanian rocks are continental in origin. Rugose and tabulate corals are common in the Viséan from the Guadiato Area. Some previous papers (Rodríguez & Falces, 1996; Rodríguez *et al.*, 2001a, b, 2002, 2004, 2007; Rodríguez, 2004; Rodríguez & Said, 2009; Rodríguez & Somerville, 2014) involved the description of some components of the assemblages recorded in that region, but a comprehensive publication including the complete assemblage is lacking. That is the purpose of this paper, as well as a homage in honour of Robert H. ('Roberto') Wagner, who studied the Peñarroya-Belmez-Espiel coalfield, provided helpful information on the neighbouring Mississippian Guadiato Area and shared with us pleasant and valuable days in the field.

The studied region is located along the Guadiato Valley that runs from NW to SE for more than 50 km and bounded by ridges composed of Precambrian to Devonian rocks (Figs 1, 2). Some hills also occur in the valleys, which are composed of resistant Mississippian limestones. The Mississippian rocks from the Guadiato Area have been divided into three tectonostratigraphic units (Cózar & Rodríguez, 1999a): Fresnedoso Unit, Viséan in age, composed mainly of siliciclastic rocks, the Sierra del Castillo Unit, composed mainly of Viséan limestones,

and the San Antonio-La Juliana Unit, composed of both, siliciclastic rocks and limestones, mostly Serpukhovian in age, but containing Viséan limestone olistolites. The coral assemblages that are described in the present paper belong to the Sierra del Castillo Unit and to the olistolites in the San Antonio-La Juliana Unit (Fig. 2). The studied outcrops are located along the Guadiato river valley, from the neighbourhood of the Fuenteagria spa (in the SE) to the vicinity of Fuenteovejuna (in the NW) (Fig. 2). In addition, the outcrops from El Casar and Campillo de Llerena are also included, because they represent the north-western prolongation of the Guadiato Area that is covered for 20 kilometres by Tertiary rocks (Fig. 1). El Casar yielded a rich assemblage, but outcrops near Campillo de Llerena are quite poor in corals and they are not included in the main sections studied (Fig. 1).

The detailed stratigraphy of the Viséan from the Guadiato Area has been published previously (Cózar & Rodríguez, 1999a, b, c, d, 2000, 2001; Cózar *et al.*, 2003; Rodríguez-Martínez *et al.*, 2003; Rodríguez *et al.*, 2007) and it will be not discussed in detail in this paper. More than 50 outcrops and sections have been studied, but only some of them yielded common or abundant corals and some others comprise Serpukhovian, not Viséan rocks. The location of the main Viséan sections is shown in Figures 2, 3 and the stratigraphic interval covered by them is shown in Figure 4. The time interval covered by the Sierra del Castillo Unit and the olistolites in the San Antonio-La Juliana Unit is quite short, comprising only the Asbian and lower Brigantian substages (Cózar & Rodríguez, 1999a; Rodríguez *et al.*, 2007; Rodríguez & Somerville, 2007). Marine Lower Viséan or Tournaisian rocks have been not recorded in Sierra Morena, and the first marine sediments in the area are related to the Upper

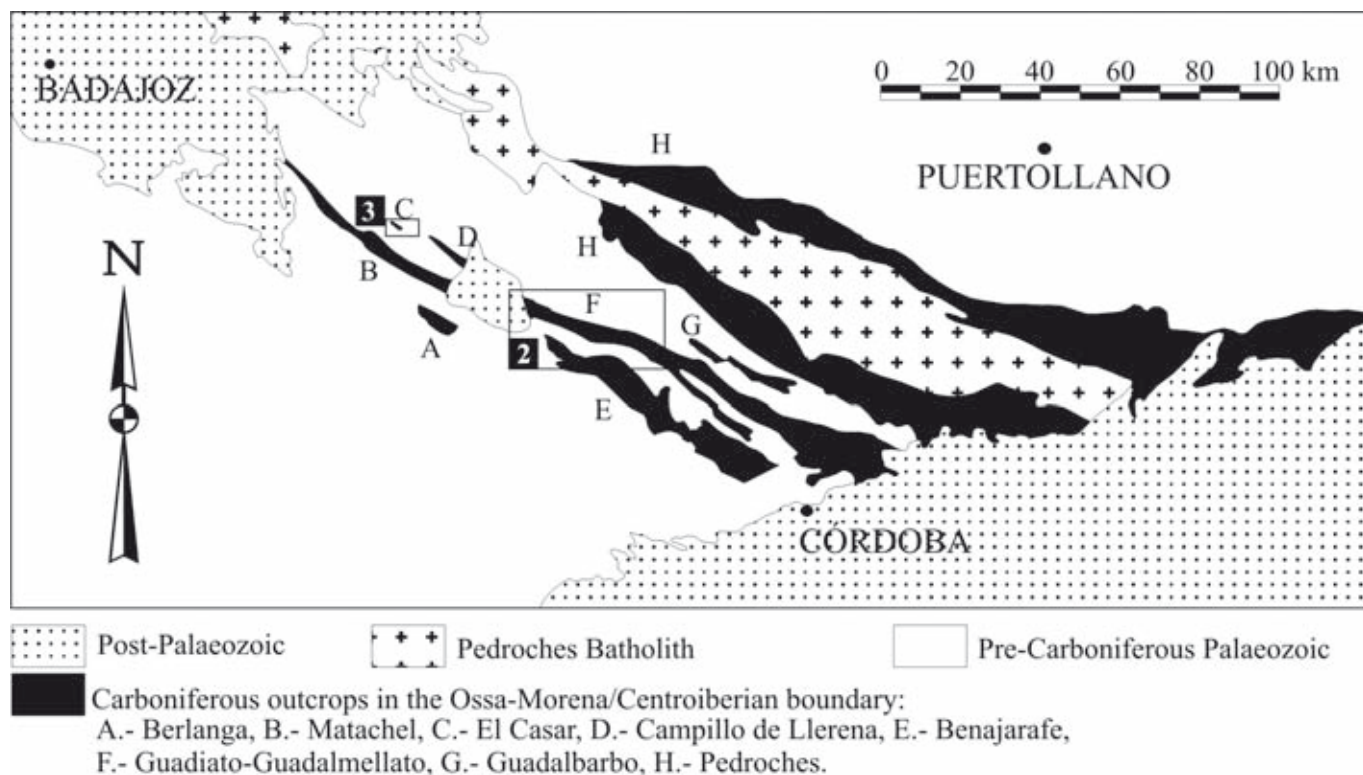


Figure 1. Location of the Guadiato Area Carboniferous outcrops in SW Spain.

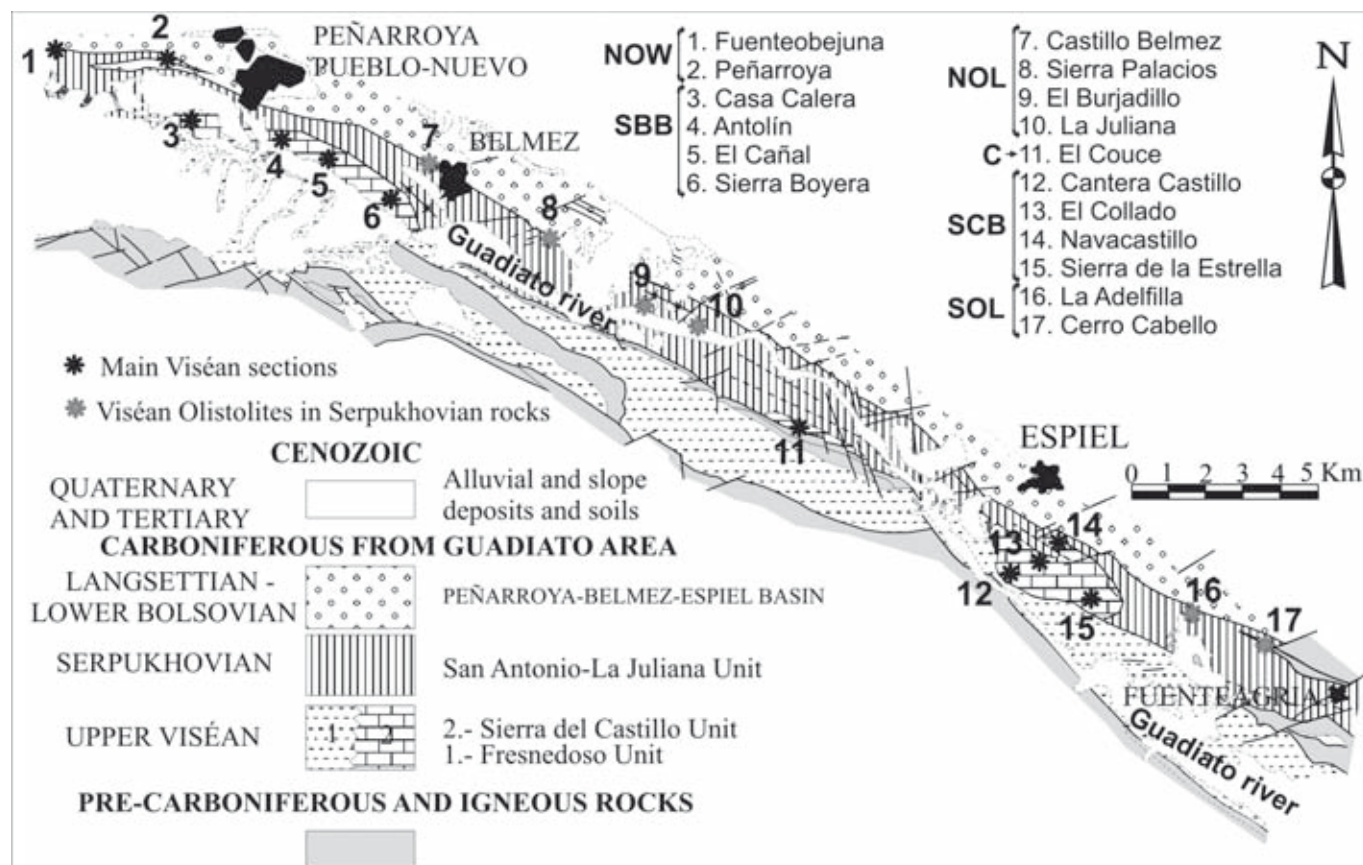


Figure 2. Location of the studied outcrops in the Guadiato Area. For location in a broader region, see Fig. 1. Modified from Cózar & Rodríguez (1999a).





all species and many longitudinal sections are provided for illustration of the Viséan coral record in the Guadiato Area, but usually only one or two figures of each species are included. Consequently, the species variability is not represented, but in the case of highly variable taxa, reference to papers where it is illustrated is specified. Some species that are still under study or without a clear specific identification are presented in open nomenclature. The geographical location and stratigraphical distribution of each species is given in Table 1 and indicated in the text.

The morphological terminology is based on that proposed by Hill (1956, 1981), with some additions by Poty (1981) and Rodríguez (1984). The microstructural descriptions are based on the terminology proposed by Semenoff-Tian-Chansky (1974) and some precisions by Rodríguez (1984). The taxonomic classification follows that of Hill (1981) with some variations following recently published papers.

Class ANTHOZOA Ehrenberg, 1834  
Subclass RUGOSA Milne-Edwards and Haime, 1850  
Order STAUROIDIA Verrill, 1865  
Suborder STREPTELASMATINA Wedekind, 1927  
Family **Antiphyllidae** Iljina, 1970  
Genus *Rotiphyllum* Hudson, 1942  
Type species *Densiphyllum rushianum* Vaughan, 1908

**Diagnosis** (after Hill, 1981). Small solitary ceratoid coral. Majors straight or slightly curved towards the cardinal fossula, with dilated base. Minors absent or short and thickened. Axial ends of septa joined in an axial column or an aulos. Septa joined in four groups in juvenile stages. Cardinal fossula on the convex side of the coral, inconspicuous in mature stages. Counter and alar fossulae occasionally present. Dissepiments absent. Tabulae conical, strongly downturned towards periphery.

*Rotiphyllum rushianum* (Vaughan, 1908)  
(Fig. 5a)

**Diagnosis** (after Poty, 1981). *Rotiphyllum* with majors joined in the centre of the corallite, forming a wide axial column, tubular in place. All elements strongly thickened.

**Distribution.** Recorded from El Couce and Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Asbian-Brigantian.

*Rotiphyllum costatum* (McCoy, 1849)  
(Fig. 5b)

**Diagnosis** (based on the description of Hudson, 1944). Medium- to large-sized *Rotiphyllum* (12.5 mm in maximum diameter and up to 26 majors), with asymmetrical septal

formula, and accelerated counter insertion in adult stages. Septa thinner towards the axis. External wall moderately thick. Minors very short or absent. Axial zone filled with stereoplasm, but may show some holes. Counter fossula may be present.

**Distribution.** Recorded from Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Asbian-Brigantian.

Genus *Claviphyllum* Hudson, 1942  
Type species *Claviphyllum eruca* McCoy, 1849

**Diagnosis** (modified after Hudson, 1942). Small, conical to conical-cylindrical solitary corals with claviphylloid septal plan. Majors straight. Counter septum rhopaloid, longer and thicker than other septa, reaching the axis. The septa KL3, KL4, CL2 and CL3, rhopaloid. The septa KL1, KL2, CL1 and C not completely developed. Cardinal part in convex side. External tabulae progressively declined towards the periphery; inner tabulae domical when present, axial tabulae sometimes depressed.

*Claviphyllum* sp.  
(Fig. 5c)

**Distribution.** Recorded from Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Upper Asbian-lower Brigantian.

Family **Laccophyllidae** Grabau, 1928  
Genus *Amplexocarinia* Soshkina, 1941 (*in* Soshkina *et al.*, 1941)  
Type species *Amplexocarinia muralis* Soshkina, 1941 (*in* Soshkina *et al.*, 1941)

**Diagnosis** (after Hill, 1981). Small, cylindrical solitary coral. Majors reaching the axis in juvenile stages but withdrawn in mature stages. Minors not developed. Axial ends of the septa forming a discontinuous aulos. Cardinal septum shorter in some cases. Tabulae spaced, mesa-shaped, resting on the tabulae next below and forming an aulos, downturned towards the periphery.

*Amplexocarinia* sp.  
(Figs 5d-5e)

**Distribution.** Recorded from El Casar, Peñarroya and El Cañal.

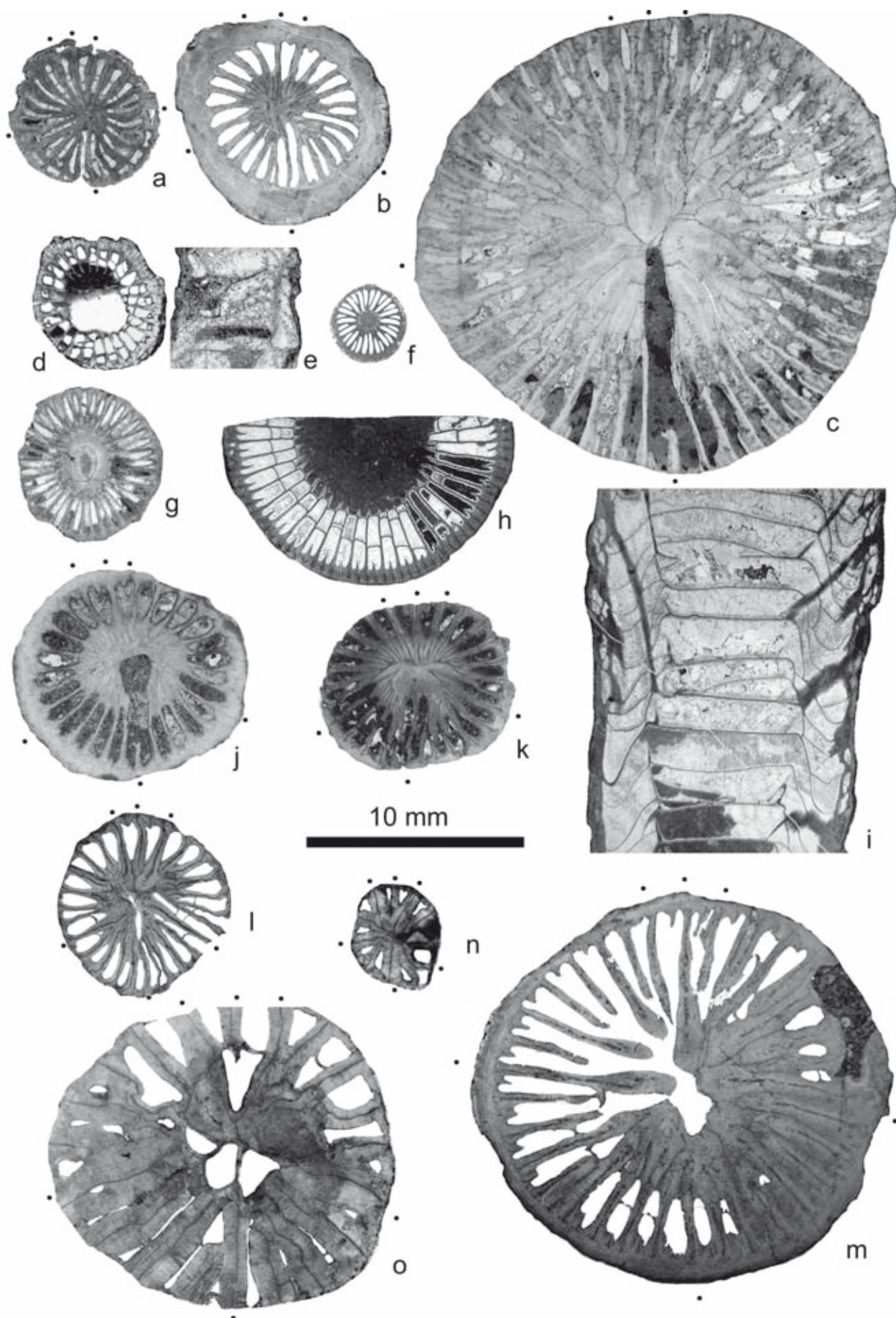
**Age.** Brigantian.

**Table 1.** Distribution of coral taxa in the Guadiato Area outcrops ordered by present geographical position. All are rugose species except for a few tabulates (TAB) and heterocorals (HETERO). The colours of the different outcrops indicates the structural unit in which they are located. NOW: Northwestern outcrops. SBB: Sierra Boyera Block. NOL: Northern Olistoliths. C: El Couce outcrop. SCB: Sierra del Castillo Block. SOL: Southern olistoliths.

| Taxa/Sections                             | NOW      |               |           | SBB               |         |          | NOL           |                 |                 |               | C          | SCB      |                  |            |              |               | SOL           |              |               |
|---|----------|---------------|-----------|-------------------|---------|----------|---------------|-----------------|-----------------|---------------|------------|----------|------------------|------------|--------------|---------------|---------------|--------------|---------------|
|   | El Casar | Fuenteobejuna | Peñarroya | Casa de la Calera | Antolín | El Cañal | Sierra Boyera | Castillo Belmez | Sierra Palacios | El Burjádillo | La Juliana | El Couce | Cantera Castillo | El Collado | Navacastillo | S. Estrella 1 | S. Estrella 2 | La Adelfilla | Cerro Cabello |
| <i>Amplexocarinia</i> sp.                 | x        |               | x         |                   |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Amplexus</i> sp.                       |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Amygdalophylloides anticuum</i>        | x        | x             | x         | x                 |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Amygdalophyllum</i> aff. <i>nexile</i> |          |               |           |                   | x       | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Arachnolasma sinense</i>               |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Auloclisia</i> sp.                     |          |               |           |                   |         |          |               |                 |                 |               |            |          | x                | x          |              |               | x             |              |               |
| <i>Aulokoninckophyllum carinatum</i>      |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               | x             |              |               |
| <i>Aulophyllum fungites</i>               |          |               |           |                   |         |          |               |                 |                 |               |            |          | x                |            |              |               |               |              |               |
| <i>Axoclisia cuspidiforma</i>             |          |               |           |                   |         | x        |               |                 |                 |               |            |          | x                |            |              |               |               |              |               |
| <i>Axophyllum cozari</i>                  |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Axophyllum densus</i>                  |          |               |           |                   |         |          | x             |                 |                 |               |            |          | x                | x          |              |               |               |              |               |
| <i>Axophyllum kirsopianum</i>             | x        | x             | x         |                   |         |          |               | x               | x               |               | x          |          |                  |            |              |               |               | x            | x             |
| <i>Axophyllum mendipense</i>              |          |               |           |                   |         | x        |               |                 |                 |               |            | x        |                  | x          |              |               |               |              |               |
| <i>Axophyllum pseudokirsopianum</i>       |          | x             | x         | x                 | x       | x        | x             |                 |                 |               |            |          |                  |            |              |               |               | x            |               |
| <i>Axophyllum spiralum</i>                | x        | x             | x         |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Axophyllum tazoultense</i>             | x        |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Axophyllum vaughani</i>                | x        |               | x         |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Caninia</i> sp.                        |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Caninophyllum bechareense</i>          |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Cladochonus</i> sp. (TAB)              |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Claviphyllum</i> sp.                   |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               | x             |              |               |
| <i>Clisiophyllum benziregense</i>         |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Clisiophyllum garwoodi</i>             |          |               | x         | x                 |         | x        | x             | x               |                 | x             |            |          | x                | x          |              |               |               | x            |               |
| <i>Cryptophyllum</i> sp.                  |          |               |           |                   |         |          |               |                 |                 |               |            | x        |                  |            |              |               | x             |              |               |
| <i>Cyathaxonia cornu</i>                  |          |               |           |                   |         |          |               |                 |                 |               |            | x        |                  |            |              |               | x             |              |               |
| <i>Cyathaxonia rushiana</i>               |          |               |           |                   |         |          |               |                 |                 |               |            | x        |                  |            |              |               | x             |              |               |
| <i>Dibunophyllum bipartitum</i>           |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            | x             | x             |              |               |
| <i>Diphyphyllum furcatum</i>              |          |               |           |                   |         |          | x             |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Diphyphyllum gracile</i>               |          |               | x         |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Espielia columellata</i>               |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Gangamophyllum gorskyi</i>             |          | x             | x         |                   |         |          |               |                 | x               |               |            |          |                  |            |              |               |               | x            | x             |
| <i>Gangamophyllum mosquense</i>           | x        |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Haplolasma lamelliferum</i>            |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Heterophyllia ornata</i> (HETERO)      |          |               |           |                   |         | x        | x             |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Hexaphyllia marginata</i> (HETERO)     |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  | x          | x            |               |               |              |               |
| <i>Koninckophyllum interruptum</i>        |          |               |           |                   |         |          | x             |                 |                 |               |            |          |                  | x          | x            |               |               |              |               |
| <i>Lithostrotion araneum</i>              |          |               |           |                   |         | x        | x             |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Lithostrotion decipiens</i>            |          |               | x         |                   |         |          |               | x               |                 |               | x          |          |                  |            |              |               |               | x            |               |
| <i>Lithostrotion vorticale</i>            |          |               |           |                   |         | x        | x             |                 |                 | x             | x          |          | x                | x          | x            | x             | x             | x            | x             |
| <i>Morenaphyllum antolinense</i>          |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Morenaphyllum boyerense</i>            |          |               |           |                   |         | x        |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Morenaphyllum</i> sp.                  |          |               | x         |                   |         |          |               |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Multithecopora</i> sp. A (TAB)         |          |               | x         |                   |         | x        | x             |                 |                 |               |            |          |                  |            | x            |               | x             |              |               |
| <i>Multithecopora</i> sp. B (TAB)         |          |               | x         |                   |         | x        | x             |                 |                 |               |            |          |                  |            |              |               |               |              |               |
| <i>Multithecopora</i> sp. C (TAB)         |          |               |           |                   |         |          |               |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Palaeosmilia murchisoni</i>            | x        | x             | x         | x                 |         | x        | x             | x               |                 |               | x          |          | x                | x          | x            | x             |               | x            | x             |
| <i>Palastrea regia</i>                    |          |               |           |                   |         |          | x             |                 |                 |               |            |          |                  |            | x            |               |               |              |               |
| <i>Pseudozaphrentoides</i> sp.            |          |               |           |                   |         |          |               |                 |                 |               |            |          | x                | x          |              |               |               |              |               |









*Amplexus* sp.  
(Figs 5h-5i)

**Distribution.** Recorded from El Cañal, Sierra Boyera Block, Sierra del Castillo Unit.

**Age.** Brigantian.

Family **Zaphrentoididae** Schindewolf, 1938  
Subfamily Hapsiphyllinae Grabau, 1928  
Genus *Zaphrentites* Hudson, 1941  
Type species *Zaphrentis parallela* Carruthers, 1910

**Diagnosis** (modified from Hill, 1981). Slightly curved, solitary corals in which axial margins of majors commonly unite around conspicuous cardinal fossula located on concave side; cardinal septum normally elongate in early stages, shortened at maturity; counter septum normally approximately equal in length to neighbouring majors but may be slightly longer and thicker; septa pinnately arranged in cardinal quadrants, radially arranged in counter quadrants, commonly withdrawn abaxially at maturity, withdrawal normally beginning in cardinal quadrants; minors very short or absent; alar pseudofossulae commonly well developed in early stages but may be inconspicuous at maturity; tabulae complete or incomplete, commonly large domes subhorizontal or gently concave in axial area, steeply depressed at periphery and in fossula; dissepiments absent; septal microstructure showing inner, thin middle line composed of microtrabeculae, flanked by wide outer fibrous layers.

*Zaphrentites delanouei* Milne-Edwards & Haime, 1851  
(Figs 5j-5k)

**Diagnosis** (after Carruthers, 1910). *Zaphrentites* maximum 13 mm in diameter and having 33 majors attached to the septa edging the cardinal fossula in the cardinal quadrants, and to the edge of the fossula in the other quadrants. Long cardinal fossula with parallel sides, occupied by a short cardinal septum. Alar fossulae well-developed.

**Distribution.** Recorded from Sierra de la Estrella 1.

**Age.** Upper Asbian and lowermost Brigantian.

Suborder PLEROPHYLLINA Sokolov, 1960  
Family **Plerophyllidae** Koker, 1924  
Genus *Ufimia* Stuckenberg, 1895  
Type species *Ufimia bradbournensis* Wilmore, 1910

**Diagnosis** (based on Hill, 1981). Solitary, small; in mature stage, four septa (alars and counter-laterals) longer, thicker and more rhopaloid than others; early stages zaphrentoid; the inner rhopaloid ends are in contact at the axis in intermediate stages of development, withdrawing and becoming free in adult stages; the longer and thicker metasepta used to be located in the middle of the quadrants; the cardinal and counter septa shorten progressively; minors rudimentary or short; tabular surfaces high, domical in shape, axially depressed; without dissepiments.

*Ufimia bradbournensis* Wilmore, 1910  
(Fig. 5l)

**Diagnosis** (based on Hudson, 1942). *Ufimia* with corallum at first cornute, later cylindrical and only slightly curved. Diameter at late growth-stage constant about 12 mm. Usual number of septa in adult stage 28. Septa straight, radial and of variable length and thickness: some septa in counter and cardinal quadrants long and markedly rhopaloid; cardinal septum shorter than other septa and about 1/3 of corallum radius; Minors contratingent but later free; counter-minors longer; marked stereocolumn, about 2/3 of corallum diameter. In and immediately below calyx, septa lanceolate or lath-shaped, not in contact and do not form stereocolumn. Cardinal fossula distinguished by short cardinal septum and opposing ends of cardinal-lateral septa, often communicate with hollow axis of stereocolumn. Alar fossulae only distinguished from other interseptal loculi by incipient counter-lateral septa.

**Figure 5.** Undissepimented rugose corals. **a)** *Rotiphyllum rushianum*. Specimen SSE/14-8, transverse section, Sierra de la Estrella 1. **b)** *Rotiphyllum costatum*. Specimen SSE/18-60, transverse section, Sierra de la Estrella 1. **c)** *Claviphyllum* sp. Specimen SSE/18-118, transverse section, Sierra de la Estrella 1. **d-e)** *Amplexocarinia* sp. **(d)** Specimen CS/7-29, transverse section, El Casar. **(e)** Specimen CS/7-38, longitudinal section, El Casar. **f)** *Cyathaxonia cornu*. Specimen SSE/15-8, transverse section, Sierra de la Estrella 1. **g)** *Cyathaxonia rushiana*. Specimen SSE/14-32, Sierra de la Estrella 1. **h-i)** *Amplexus* sp. Specimen CAÑ/1-23, El Cañal, **(h)** transverse section; **(i)** longitudinal section. **j-k)** *Zaphrentites delanouei*. **(j)** Specimen SSE/18-81, transverse section, Sierra de la Estrella 1. **(k)** Specimen SSE/14-82, transverse section, Sierra de la Estrella 1. **l)** *Ufimia bradbournensis*. Specimen SSE/18-110, transverse section, Sierra de la Estrella 1. **m)** *Sochkineophyllum*? sp. Specimen SSE/18-18, transverse section, Sierra de la Estrella 1. **n-o)** *Cryptophyllum* sp. Specimen SSE/10-33, transverse sections, Sierra de la Estrella 1. **(n)** Young stage. **(o)** Adult stage. Proto-septa are indicated by black dots. Scale bar same for all pictures.

**Distribution.** Recorded from El Couce and Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Upper Asbian-lower Brigantian.

Family **Polycoeliidae** de Fromentel, 1861  
Subfamily Polycoeliinae de Fromentel, 1861  
Genus *Sochkineophyllum* Grabau, 1928  
Type species *Plerophyllum artiense* Soshkina, 1925

**Diagnosis** (modified from Moore & Jeffords, 1941 and Cotton, 1984). Trochoid/ceratoid, moderately large; epitheca with longitudinal grooves; moderately deep calice. counter prominent reaching the centre of the section where it is thickened, but not forming column. Septa that do not reach the axis, typically 7 thickened, K, alars, 1 or 2 in each quadrant (cardinal or counter) and in all cases, the last of each series; in primitive species the thickenings are less conspicuous. Short cardinal; well marked fossula even in early stages. Tabulae well developed, more or less axially bent, usually irregular and depressed in the cardinal interseptum. No dissepiments.

*Sochkineophyllum?* sp.  
(Fig. 5m)

**Distribution.** Recorded in Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Upper Asbian-lower Brigantian.

Family **Pentaphyllidae** Schindewolf, 1942  
Genus *Cryptophyllum* Carruthers, 1919  
Type species *Cryptophyllum hibernicum* Carruthers, 1919

**Diagnosis** (after Fedorowski, 2009). Solitary, non-dissepimented; cardinal protoseptum, alar and counter-lateral septa strongly dominate; may meet at corallite axis or free axially; counter protoseptum permanently underdeveloped from the beginning of septogenesis; septal grooves very inconspicuous or absent.

*Cryptophyllum* sp.  
(Figs 5n-5o)

**Distribution.** Recorded from El Couce and Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Upper Asbian-lower Brigantian.

Suborder CYATHOPHYLLINA Nicholson, 1889  
Family **Cyathopsidae** Dybowski, 1873  
Genus *Caninia* Michelin in Gervais, 1840

Type species *Caninia cornucopiae* Michelin in Gervais, 1840

**Diagnosis** (after Hill, 1981). Ceratoid to cylindrical solitary coral. Cardinal fossula on the convex side of the corallite. In juvenile stages, majors long and thickened in the cardinal quadrants. In mature stages, septa withdrawn and thin, straight or curved towards the cardinal septa. Counter septum often longer. Minors short. Dissepimentarium narrow, made of simple interseptal dissepiments and, in rare cases, first and second order lonsdaleoid dissepiments. Tabulae complete, horizontal in the axial zone, depressed in periphery.

*Caninia* sp.  
(Fig. 6a)

**Distribution.** Recorded from El Collado, Sierra del Castillo Unit.

**Age.** Brigantian.

Genus *Siphonophyllia* Scouler in McCoy, 1844  
Type species *Siphonophyllia cylindrica* Scouler in McCoy, 1844

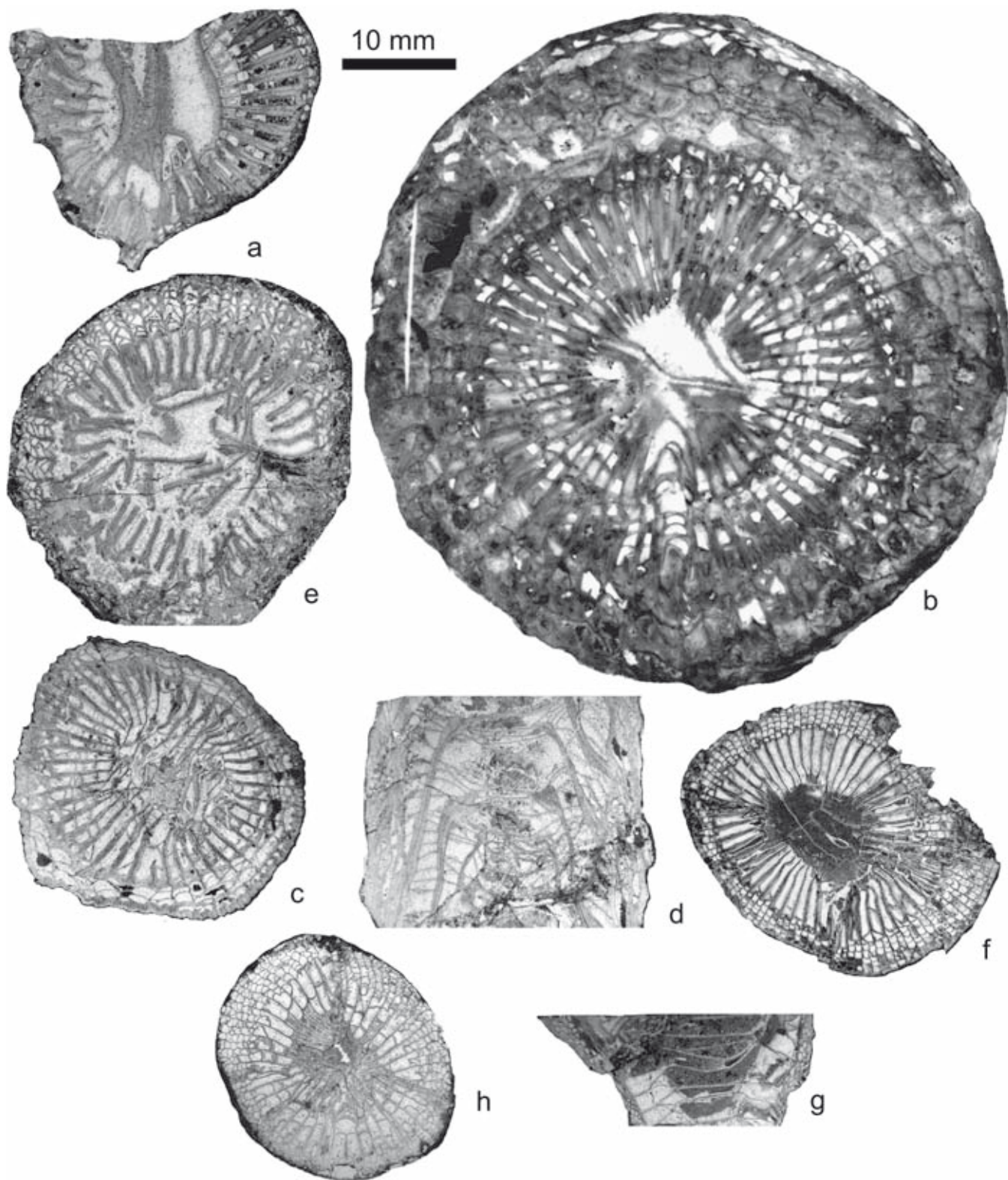
**Diagnosis** (modified from Poty & Boland 1994). Large cylindrical solitary coral. Majors numerous and long but not extending to the axis. Minors reaching the inner edge of the dissepimentarium. Septa thickened in the tabularium, particularly in the cardinal quadrants. Cardinal fossula usually well developed, with a shorter and thicker cardinal septum. Counter fossula may develop, with a shorter and thicker counter septum. Dissepimentarium wide, made of many rows of simple interseptal, V-shaped, herringbone, first and second order lonsdaleoid dissepiments. Outer wall simple and thick. Tabulae complete and horizontal in central zone, incomplete and depressed in periphery.

*Siphonophyllia samsonensis* (Salée, 1913)  
(Fig. 6b)

**Diagnosis** (after Poty 1981). Large subcylindrical *Siphonophyllia*. Majors long, thickened in the dissepimentarium. Minors discontinuous, short or appearing as septal crests. Cardinal fossula well-developed. Dissepimentarium narrow, made of simple, V-shaped, herringbone and rare lonsdaleoid dissepiments. Tabulae horizontal in the axial zone and depressed in periphery.

**Distribution.** Recorded from Antolín, Sierra Boyera, Cantera Castillo, El Collado, Sierra del Castillo Unit.

**Age.** Upper Asbian, lower Brigantian.



**Figure 6.** Cyathopsidae. **a)** *Caninia* sp. Specimen COL/7-12, El Collado, transverse section. **b)** *Siphonophyllia samsonensis*. Specimen ANT3/1-7, Antolín, transverse section. **c-d)** *Siphonophyllia siblyi*. Specimen COL/5b-11, El Collado (**c**) transverse section; (**d**) longitudinal section. **e)** *Pseudozaphrentoides* sp. Specimen CCS/10-4, Cantera Castillo, transverse section. **f-g)** *Haplolasma lamelliferum*. Specimen COL/7-10, El Collado, transverse section. **h)** *Caninophyllum becharensense*. Specimen ANT/1-59, Antolín, transverse section. Scale bar same for all pictures.



*Siphonophyllia siblyi* Semenoff-Tian-Chansky, 1974  
(Figs 6c-6d)

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). *Siphonophyllia* intermediate in size. Majors long (1/2-1/3 as long as the radius), usually sinuous and thickened in the dissepimentarium. Minors poorly developed or appearing as septal crests. Cardinal fossula well-developed. Dissepimentarium wide made of simple, Vshaped, herringbone and narrow lonsdaleoid dissepiments of both orders.

**Distribution.** Recorded from Sierra Palacios (SanAntonio-La Juliana Unit), Cantera Castillo and El Collado (Sierra del Castillo Unit).

**Age.** Asbian-Brigantian.

Genus *Pseudozaphrentoides* Stuckenberg, 1904

Type species *Pseudozaphrentoides jerofoewi* Stuckenberg, 1904

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Conical to cylindrical solitary coral or with limited offsets. Majors thickened in the dissepimentarium. Minors short, rudimentary or absent. Cardinal fossula marked by a shorter cardinal septum. Dissepimentarium 1/3 as wide as the radius of the corallite, made of simple interseptal, V-shaped and herringbone dissepiments. Tabulae complete and horizontal.

*Pseudozaphrentoides* sp.  
(Fig. 6e)

**Distribution.** Recorded from Cantera Castillo and El Collado, Sierra del Castillo Unit.

**Age.** Asbian-Brigantian).

Genus *Haplolasma* Semenoff-Tian-Chansky, 1974

Type species *Caninia subibicina* McCoy, 1851

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary coral. Majors long but withdrawn from the axis with a large free zone in the central part of the tabularium. Minors short less than half the length of the majors. Small cardinal fossula with a shorter cardinal septum. Dissepimentarium of various widths, made of small simple and V-shaped dissepiments.

*Haplolasma lamelliferum* Semenoff-Tian-Chansky, 1974  
(Figs 6f-6g)

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). *Haplolasma* close to *H. subibicinum* in its macrostructure,

but clearly different in its microstructure; it shows a thick lamellar stereoplasm.

**Distribution.** Recorded from El Collado, Sierra del Castillo Unit.

**Age.** Uppermost Asbian-Brigantian).

Family **Bothrophyllidae** Fomichev, 1953

Genus *Caninophyllum* Lewis, 1929

Type species *Cyathophyllum archiaci* Milne-Edwards & Haime, 1852

**Diagnosis** (after Hill, 1940). Simple trochoid rugose coral with a deep open fossula and long majors typically dilated in the wide tabularium, which consists of broadly domed tabulae with down-turned edges. The minors are long and the dissepimentarium wide, consisting of fine angular dissepiments.

*Caninophyllum becharense* Semenoff-Tian-Chansky,  
1974  
(Fig. 6h)

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary, trochoid to cylindrical coral of moderate dimensions (maximum diameter 25 mm). In young and middle stages, the septa are strongly thickened in the tabularium and reach the centre, where they join in a rudimentary axial structure. In distal stages the dissepimentarium width reach half of the coral radius and the septa withdraw from axis, leaving a free zone of 5 mm in diameter. The minors rarely reach the dissepitheca. Presence in some stages of transeptal dissepiments of first and second order. Cardinal septum short. Axial tabulae more or less complete, horizontal or axially depressed, bent in the borders. Microstructure composed of thin mesoplasm covered by thick fibrous stereoplasm in continuity with that of the dissepitheca. Some tabulae are also covered of thick fibrous stereoplasm.

**Distribution.** Recorded from Antolín, Sierra Boyera Block, Sierra del Castillo Unit.

**Age.** Brigantian.

Family **Aulophyllidae** Dybowski, 1873

Subfamily Aulophyllinae Dybowski, 1873

Genus *Aulophyllum* Milne-Edwards & Haime, 1850

Type species *Clisiophyllum prolapsum* McCoy, 1849

**Diagnosis** (after Poty, 1981). Sub-cylindrical solitary coral with a complex axial structure. Majors long but not connected to the axial structure, often thickened in the cardinal parts of the tabularium. Minors half as long as the

majors. Cardinal septum slightly shorter, except in juvenile stages. Axial structure dense forming a well-defined column with a circular shape and cuspidate towards the cardinal fossula, made of densely packed radial lamellae and axial tabulae with no median plate. Cardinal fossula in the convex side of the corallite. Dissepimentarium wide, made of small simple dissepiments. Tabulae incomplete and depressed in the outer part of the tabularium. Axial tabulae densely packed, downturned towards the axis and towards the outer part of the axial column.

*Aulophyllum fungites* (Fleming, 1828)  
(Fig. 7a)

**Diagnosis.** Same as for the genus.

**Distribution.** Recorded from Cantera Castillo, Sierra del Castillo Unit.

**Age.** Asbian.

Genus *Auloclisia* Lewis, 1927

Type species *Auloclisia mutata* Lewis, 1927

**Diagnosis** (modified from Lewis, 1927). Solitary rugose coral with an axial structure bounded by a wall that sticks out in the calice forming a conspicuous dome. It is composed of large bent tabellae crossed by radial lamellae in lower number than septa. In young stages it shows a median plate; in adult stages, it disappears. Majors are straight, thickened in the tabularium. Cardinal fossula well-marked and moderately wide. The dissepimentarium is narrow and develops late.

*Auloclisia* sp.  
(Figs 7b-7d)

**Distribution.** Recorded in Cantera Castillo, El Collado and Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Asbian and lowermost Brigantian.

Subfamily Clisiophyllinae Nicholson, 1889

Genus *Clisiophyllum* Dana, 1846

Type species *Clisiophyllum keyserlingi* McCoy, 1849

**Diagnosis** (modified from Semenoff-Tian-Chansky, 1974; Hill, 1981; Poty, 1981). Solitary coral with numerous radially arranged, long majors reaching or closely approaching axial column, Minors generally well developed, rarely penetrating outer tabularium, cardinal septum shortened in late stages, in open cardinal fossula. Axial structure consists of median lamella and numerous radial or spirally arranged septal lamellae in axial column formed by continuous series of steeply elevated, linked

axial tabellae. Tabularium weakly biform where penetrated by minors, tabulae incomplete, tabellae generally convex, less steeply elevated and fewer than those in axial column. Dissepimentarium regular, with small, concentric and, less commonly, herringbone dissepiments. Septa composed mainly of fibrous mesoplasm. Fibrous stereoplasm may sporadically occur.

*Clisiophyllum benziregense* Semenoff-Tian-Chansky, 1974  
(Fig. 7e)

**Diagnosis** (modified from Semenoff-Tian-Chansky, 1974). Trochoid to ceratoid, slightly bent corals. The septa are strongly thickened in the tabularium. The axial structure is dense, with a thick median plate and about 20 radial lamellae irregularly thickened, denser in the periphery. In longitudinal section, an axial series of dense tabulae (20-30 in 10 mm), steeply declined to the periphery and a periaxial series of tabulae less declined and less dense (12-18 in 10 mm). The septal microstructure is composed of mesoplasm in the inner part and mesoplasm and stereoplasm in the dissepimentarium.

**Distribution.** Recorded from El Collado, Sierra del Castillo Unit.

**Age.** Uppermost Asbian-lowermost Brigantian.

*Clisiophyllum garwoodi* (Salée, 1913)  
(Figs 7f-7g)

**Diagnosis** (after Poty, 1981). Small *Clisiophyllum*, 9.7 mm in average diameter (maximum 14.3 mm), and having 31 (maximum 41) majors. Minors shorter than the dissepimentarium width, very short in some cases. Axial structure 1/3-1/4 as wide as the diameter of the corallite, dense, symmetrical or poorly developed with few radial lamellae. Wide dissepimentarium.

**Distribution.** Recorded from Peñarroya, Casa de la Calera, El Cañal, Sierra Boyera, Castillo Belmez, El Burjádillo, Cantera Castillo, El Collado, La Adelfilla (San Antonio- La Juliana and Sierra del Castillo Units).

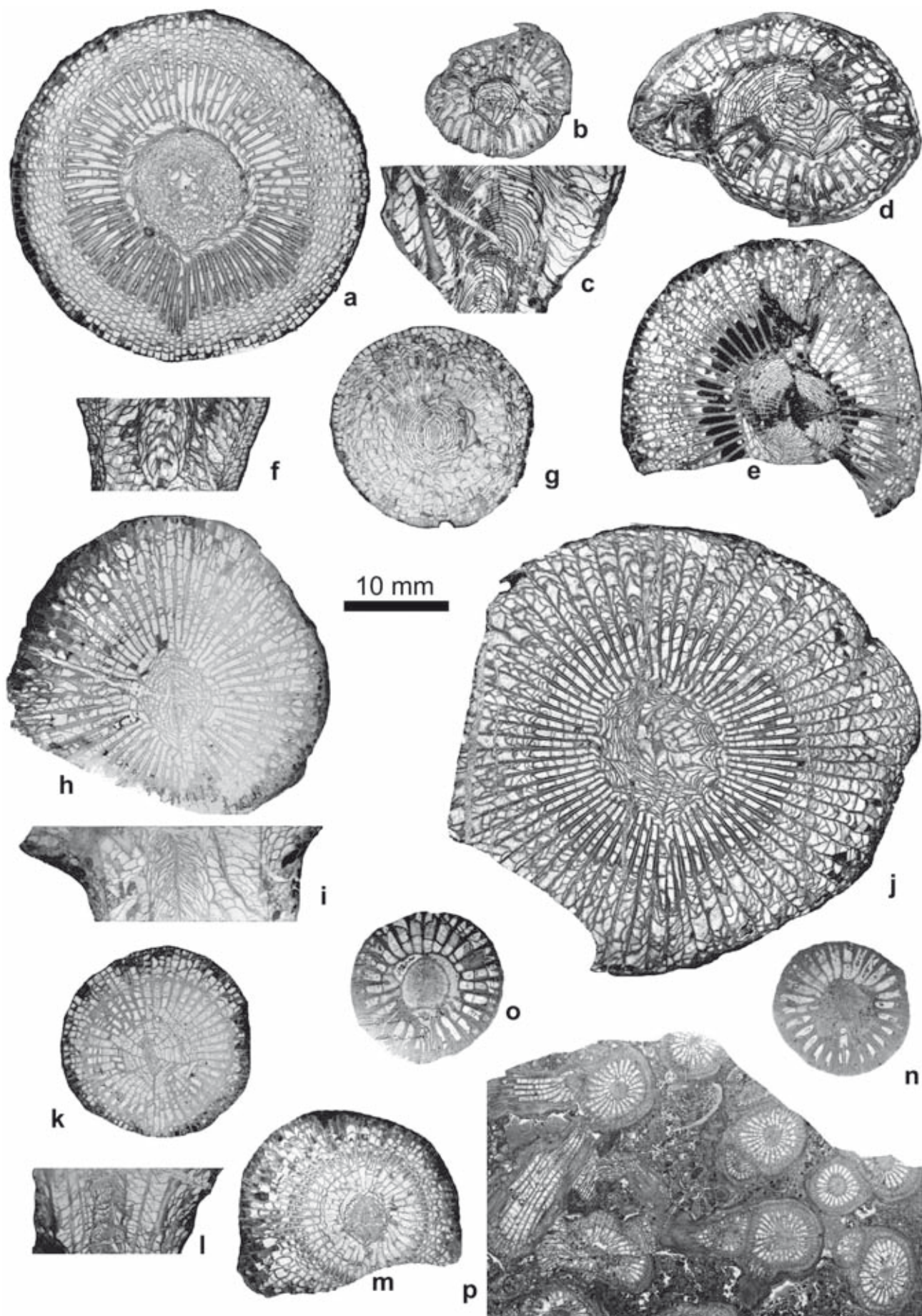
**Age.** Asbian-Brigantian.

Genus *Axoclisia* Semenoff-Tian-Chansky, 1974

Type species *Axoclisia cuspidiforma* Semenoff-Tian-Chansky, 1974

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Clisiophylloid solitary coral. Majors usually thickened in the tabularium. Minors long and present as septal crests in the dissepimentarium. Axial structure made of a thick axial plate, some radial lamellae and axial tabulae. Axial plate







connected to the cardinal and, in some cases, to the counter septum. Radial lamellae occasionally connected to the axial ends of the majors. Dissepimentarium made of large simple and second order lonsdaleoid dissepiments. Axial tabulae upturned towards the axial plate. Periaxial tabulae domal and downturned towards the dissepimentarium.

*Axoclisia cuspidiforma* Semenoff-Tian-Chansky, 1974  
(Figs 7h-7i)

**Diagnosis** (modified from Semenoff-Tian-Chansky, 1974). Solitary coral with elisiophylloid axial structure, with diameter reaching 1/3 of the total diameter. Majors long, almost reaching the axial structure. Minors thin, cut by transeptal dissepiments of second order. Regular, rarely cross inner dissepiments. Thick median plate, joined to the cardinal septum, which is located in a well marked fossula. Many radial lamellae intersected by tabellae. Long and steeply declined dissepiments. Convex axial tabellae declined to the periphery. Granulo-fibrous septa at the periphery, fibrous in the tabularium. Lamellar stereoplasm in the dissepimentarium.

**Distribution.** Recorded from Antolín and Cantera Castillo, Sierra del Castillo Unit.

**Age.** Asbian-Brigantian.

Subfamily Dibunophyllinae Wang, 1950

Genus *Dibunophyllum* Thomson & Nicholson, 1876

Type species *Dibunophyllum bipartitum* Thomson & Nicholson, 1876

**Diagnosis** (after Hill, 1940). Large, simple rugose coral, whose variable axial structure is typically 1/3 as wide as the corallum, and consists of a long median plate, a few (usually four to eight) septal lamellae on either side, and numerous tabellae, sloping steeply down at its periphery; less typically the lamellae may become curved, the median plate disappears, and the bilaterally radiate arrangement lost. Minors are short; the width of the dissepimentarium is about 2/3 the length of the majors, which is 2/3 the radius of the corallite; the dissepiments

are frequently inosculating. Tabulae are incomplete and bracket-shaped; the tabellae are of two series, the plates of the outer series being fewer and less steeply declined than those of the inner series. The septa are not curved about the small fossula.

*Dibunophyllum bipartitum* (McCoy, 1849)  
(Fig. 7j)

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary, large coral with a variable axial structure that reach 1/3 of the diameter. It is composed of a median lamella, a small number of radial lamellae and tabulae inclined to the periphery. The lamellae are usually anastomosed or winding. The dissepimentarium is wide, with short minors and angulate to inosculate, occasionally regular dissepiments. In rare cases the minors are long, reaching the inner border of the dissepimentarium. The septa are commonly thick in the tabularium, mainly in the cardinal quadrants. The tabulae are incomplete, tent-shaped and divided in two series: axial and periaxial. The wall is lamellar with fibrous intercalations. The septa show a thin, irregular mesoplasm. The stereoplasm only occurs in the outer parts of the septa, and on some dissepiments or tabulae.

**Distribution.** Recorded from El Collado, Navacastillo and Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Brigantian.

Genus *Arachnolasma* Grabau, 1922

Type species *Lophophyllum sinense* Yabe & Hayasaka, 1920

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary coral with well-developed dissepimentarium. Axial structure having a small diameter (about 1/5 of the alar diameter), composed of a thick median lamella and a low number of radial lamellae. The axial tabulae are more-or-less well differentiated from the rest of the tabularium and strongly declined from the median lamella to the periphery. Septa with two phases of secretion, with the stereoplasm fibrous or lamellar in different species.

**Figure 7.** Aulophyllidae. **a)** *Aulophyllum fungites*. Specimen CCS/9-4, Cantera Castillo, transverse section. **b-d)** *Auloclisia* sp. Specimen CCS/9-9, Cantera Castillo, **(b)** transverse section, young stage; **(c)** longitudinal section; **(d)** compressed transverse section, adult stage. **e)** *Clisiophyllum benziregense*. Specimen COL/6-1, El Collado, broken transverse section. **f-g)** *Clisiophyllum garwoodi*. Specimen SSE/9-1, Sierra de la Estrella 1. **(f)** longitudinal section; **(g)** transverse section. **h-i)** *Axoclisia cuspidiforma*. Specimen CCS/9-1, Cantera Castillo, **(h)** transverse section; **(i)** longitudinal section. **j)** *Dibunophyllum bipartitum*. Specimen SSE/10-102, Sierra de la Estrella 1, transverse section. **k)** *Arachnolasma sinense*. Specimen COL/13-19, El Collado, transverse section. **l-m)** *Amygdalophyllum* aff. *nexile*. Specimen ANT/2-1-35, Antolín, **(l)** longitudinal section; **(m)** transverse section. **n-o)** *Rylstonia benecompecta*. Specimen SSE/10-10, Sierra de la Estrella 1, **(n)** transverse section, early adult stage; **(o)** Advanced adult stage. **p)** *Espielia columellata*. Specimen COL/-8-1, El Collado, transverse section. Scale bar same for all pictures.

*Arachnolasma sinense* (Yabe & Hayasaka, 1920)  
(Fig. 7k)

**Diagnosis** (after Fedorowski, 1971). *Arachnolasma* with up to 28 mm in diameter and 47 to 61 septa of each order; dibunophylloid axial structure, occupying 1/5 of the corallite diameter and conspicuous also in longitudinal section. Minors short.

**Distribution.** Recorded from El Cañal and El Collado, Sierra del Castillo Unit.

**Age.** Brigantian.

Subfamily Amygdalophyllinae Grabau in Chi, 1935  
Genus *Amygdalophyllum* Dun & Benson, 1920

Type species *Amygdalophyllum etheridgei* Dun & Benson, 1920

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary coral with an axial structure. Majors usually long and connected to the axial structure, commonly thickened and carinate. Minors half as long and thinner than the majors, carinate or contratingent in some cases. Cardinal septum slightly shorter. Cardinal fossula variably developed. Axial structure made of a strong thickened axial plate, many radial lamellae, connected to the axial ends of the majors, and upturned tabulae. In some cases, axial structure reduced to some radial lamellae and tabulae. Dissepimentarium usually wide, made of simple interseptal and V-shaped dissepiments. In rare cases, some lonsdaleoid dissepiments of both orders are present. Inner row of dissepiments usually thickened. Outer wall simple and thin.

*Amygdalophyllum* aff. *nexile* Vassiljuk, 1964  
(Figs 7l-7m)

**Distribution.** El Cañal and Antolín, Sierra Boyera Block, Sierra del Castillo Unit.

**Age.** Brigantian.

Genus *Rylstonia* Hudson & Platt, 1927

Type species *Rylstonia benecompecta* Hudson & Platt, 1927

**Diagnosis** (after Hill 1981). Ceratoid or cylindrical solitary coral. Majors thickened in the whole corallite in juvenile stages. Majors thickened in the cardinal quadrants of the tabularium in mature stage. Minors short or not developed. Axial structure made of an axial plate connected to (nearly) all majors, several radial lamellae and tabulae. Cardinal fossula well marked, with a short and thin cardinal septum. Dissepimentarium narrow, made of

regular dissepiments and rare herringbone and lonsdaleoid dissepiments. Outer wall simple or festooned. Tabulae almost complete, downturn towards the periphery.

*Rylstonia benecompecta* Hudson & Platt, 1927  
(Figs 7n-7o)

**Diagnosis** (after Hudson & Platt, 1927). *Rylstonia* maximum 17 mm in diameter and having 28 majors. Axial structure connected to the cardinal and counter septa. Radial lamellae mostly connected to the axial ends of the majors. Tabulae depressed in periphery, forming a gutter.

**Distribution.** Recorded from El Couce and Sierra de la Estrella 1, Sierra del Castillo Unit.

**Age.** Upper Asbian-Brigantian.

Genus *Espielia* Rodríguez & Hernando, 2005

Type species *Espielia columellata* Rodríguez & Hernando, 2005

**Diagnosis** (after Rodríguez & Hernando, 2005). Fasciculate corals with thick wall, one to three rows of regular dissepiments, long and straight septa that reach the massive columella. Columella is thick (1/3 to 1/5 of corallite diameter) with inner structure composed of medial plate and numerous radial lamellae. Tabulae are globose, gently inclined from the columella towards the periphery. Increase is peripheral. Microstructure is mainly fibrous; wall, septa and columella are composed of fascicles of fibres; dissepiments and tabulae are granular showing sporadic lamellar thickenings.

*Espielia columellata* Rodríguez & Hernando, 2005  
(Fig. 7p)

**Diagnosis.** As for the genus and the mean alar diameter varies from 6 to 7 mm, the mean tabularium diameter varies from 4.5 to 5.5 mm and the mean number of septa varies from 23.5 to 25.5.

**Distribution.** Recorded from El Collado.

**Age.** Lowermost Brigantian.

Family *Palaeosmiliidae* Hill, 1940

Genus *Palaeosmilia* Milne-Edwards & Haime, 1848

Type species *Palaeosmilia muchisoni* Milne-Edwards & Haime, 1848

**Diagnosis** (after Rodríguez *et al.*, 2013). Solitary corals with numerous septa radially disposed; long minors; some majors reach the axis. The cardinal fossula is narrow and reaches the axis. Incomplete tabulae disposed in two series.

An axial series composed of globose tabellae, with the axial zone slightly depressed, and a periaxial series composed of convex tabellae that may be declined towards the dissepimentarium. Numerous, small, regular dissepiments that may be replaced in the periphery by transeptal and/or naotic dissepiments. The microstructure is composed of a lamellar wall and fibrous septa. The peripheral part of the septa (dissepimentarium) is trabecular, but the inner zone of the septa (tabularium) is composed of fibres with water-jet disposition.

*Palaeosmilia murchisoni* Milne-Edwards & Haime, 1848  
(Fig. 8a)

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary, turbinate to cylindrical, more or less curved *Palaeosmilia* that may reach large size (10 cm in diameter). A large number of septa reach the axis. Narrow fossula that reaches the axis, where it widens. Long minors that reach 1/2 to 2/3 of the radius of the coral. Axial tabulae incomplete forming a central dome with a depressed axial zone. Lamellar wall and totally fibrous septa without discontinuity between the mesoplasm and stereoplasm. The septa may be trabecular, at least in part. Stereoplastic thickenings occur on thick dissepiments.

**Distribution.** Recorded in all outcrops from the Guadiato Area except from Antolín, Sierra Palacios, Burjádillo and El Couce.

**Age.** Asbian and Brigantian.

Genus *Palastraea* McCoy, 1851  
Type species *Astraea carbonaria* McCoy, 1849

**Diagnosis** (after Hill, 1981). Cerioid, astreoid, or aphroid *Palaeosmilia*.

*Palastraea regia* (Phillips, 1836)  
(Fig. 8b)

**Diagnosis.** Colonial coral with numerous septa radially disposed; long minors; some majors may reach the axis. The cardinal fossula is narrow and reaches the axis. Incomplete tabulae disposed in two series. An axial series composed of globose tabellae, with the axial zone slightly depressed, and a periaxial series composed of convex tabellae that may be declined to the dissepimentarium. Numerous, small, regular dissepiments that may be replaced in the periphery by transeptal and/or naotic dissepiments. The peripheral part of the septa (dissepimentarium) is trabecular, but the inner zone of the septa (tabularium) is composed of fibres with water-jet disposition.

**Distribution.** Recorded from El Cañal and El Collado.

**Age.** Brigantian.

Genus *Aulokoninckophyllum* Sando, 1976  
Type species *Campophyllum carinatum* Carruthers, 1909

**Diagnosis** (modified from Sando, 1976). Solitary or pseudo-fasciculate aulac coral in which aulos is poorly defined and formed mainly by union of the axial ends of majors and partly by tabulae. Majors long, carinate; carinae of zig-zag type. Cardinal fossula ordinarily present. Dissepimentarium regular. Tabulae in aulos ordinarily flat, horizontal; tabulae in tabularium complete or incomplete, sloping down towards periphery of corallite. Increase seemingly lateral or peripheral. Septal microstructure trabecular.

*Aulokoninckophyllum carinatum* (Carruthers, 1909)  
(Fig. 8c)

**Diagnosis** (modified from Sando, 1976). Solitary (conical to cylindrical) or pseudo-fasciculate *Aulokoninckophyllum* with mature corallites 10-28 mm in diameter, 24-54 ordinarily strongly carinate majors and an equal number of long minors (1/2 to 2/3 length of majors), a poorly formed aulos 3-5 mm in diameter, tabulae numbering about 6-16 in 5 mm in the aulos and about 7-10 in 5 mm in the tabularium, and a dissepimentarium 2-10 mm wide composed of 4-16 rows of regular dissepiments. Cardinal fossula weakly to strongly developed. Increase seemingly lateral or peripheral. Septal microstructure trabecular in the dissepimentarium, water-jet fibrous in the tabularium.

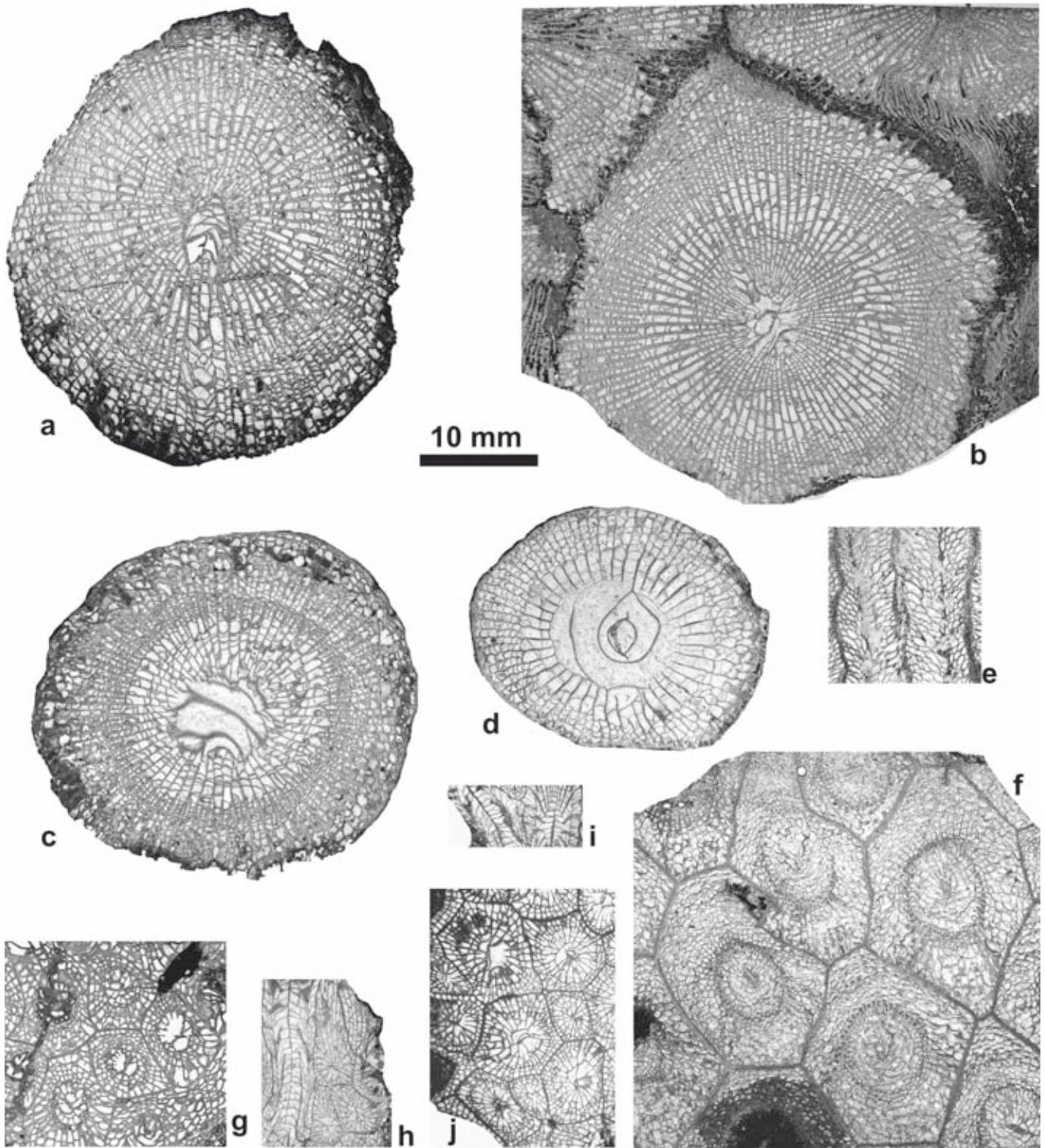
**Distribution.** Recorded from Sierra de la Estrella 1.

**Age.** Upper Asbian.

Genus *Koninckophyllum* Thomson & Nicholson, 1876  
Type species *Koninckophyllum magnificum* Thomson & Nicholson, 1876

**Diagnosis** (after Hill, 1939). Large solitary coral with numerous septa. Majors long but withdrawn from the axis, often thickened in the outer part of the tabularium, particularly in the cardinal quadrants. Minors long, often discontinuous in the dissepimentarium. In juvenile stages, clisiophylloid axial structure connected to the counter septum. In mature stages, axial structure reduced to a simple columella supported by conical tabulae, absent in some cases. Cardinal fossula indenting the dissepimentarium.





**Figure 8.** Palaeosmiliidae and massive lithostrotionidae. **a)** *Palaeosmilia munchsoni*. Specimen SSE/18-2, transverse section, Sierra de la Estrella 1. **b)** *Palastraea regia*. Specimen COL/9-1, El Collado, transverse section. **c)** *Aulokoninckophyllum carinatum*. Specimen SSE/10-105, transverse section, Sierra de la Estrella 1. **d)** *Koninckophyllum interruptum*. Specimen COL/14-6, El Collado, transverse section. **e-f)** *Lithostrotion araneum*. Specimen ANT1/1-25, Antolín, **(e)** longitudinal section; **(f)** transverse section. **g-h)** *Lithostrotion decipiens*. Specimen SSE2/21-6, Sierra de la Estrella 2, **(g)** transverse section; **(h)** longitudinal section. **i-j)** *Lithostrotion vorticale*. Specimen SSE2/22-1, Sierra de la Estrella 2, **(i)** longitudinal section; **(j)** transverse section. Scale bar same for all pictures.

*Koninckophyllum interruptum* Thomson & Nicholson,  
1876  
(Fig. 8d)

**Diagnosis** (after Semenoff-Tian-Chansky, 1974). Solitary *Koninckophyllum* with axial structure more rudimentary than *K. magnificum*. Possible presence of lonsdaleoid dissepiments. Fibrous septa composed of thick mesoplasm with undulated borders and stereoplasm only in the tabularium.

**Distribution.** Recorded from El Cañal, Cantera Castillo and El Collado, Sierra del Castillo Unit.

**Age.** Asbian-Brigantian.

Family **Lithostrotionidae** D'Orbigny, 1852  
Genus *Lithostrotion* Fleming, 1828  
Type species *Lithostrotion striatum* Fleming, 1828  
[*Lithostrotion vorticale* (Parkinson, 1808)]

**Diagnosis** (after Poty, 1981). Cerioid colonial coral. Majors long, extending to the axis and commonly connected to the columella. Minors extending to the inner edge of the dissepimentarium or slightly entering the tabularium. Columella lath-like, connected to the counter septum. Dissepimentarium of various widths, made of simple interseptal dissepiments and occasional lonsdaleoid dissepiments. Tabulae incomplete. Axial tabulae conical and peripheral tabulae horizontal or declined towards the dissepimentarium. Increase lateral and non-parricidal.

*Lithostrotion araneum* (McCoy, 1844)  
(Figs 8e-8f)

**Diagnosis** (after Poty, 1981). Large *Lithostrotion*, maximum 5.3 mm in tabularium diameter and having 30 majors. Minors usually short. Dissepimentarium wide, made of numerous rows of simple interseptal, V-shaped, herringbone dissepiments and occasional lonsdaleoid dissepiments.

**Distribution.** Recorded from Antolín and El Cañal.

**Age.** Brigantian.

*Lithostrotion decipiens* (McCoy, 1849)  
(Figs 8g-8h)

**Diagnosis** (after Poty, 1981). Medium-sized *Lithostrotion*, maximum 3 mm in tabularium diameter and a having maximum of 18 majors.

**Distribution.** Recorded from Fuenteobejuna, La Juliana, Sierra Boyera and Sierra de la Estrella 2.

**Age.** Brigantian.

*Lithostrotion vorticale* (Parkinson, 1808)  
(Figs 8i-8j)

**Diagnosis** (after Poty, 1981). Medium-sized *Lithostrotion*, maximum 4.1 mm in tabularium diameter and having a maximum of 24 majors.

**Distribution.** Recorded from Antolín, El Cañal, El Burjadillo, La Juliana, Cantera Castillo, El Collado, Navacastillo, Sierra de la Estrella 1 and 2, La Adelfilla and Cerro Cabello.

**Age.** Upper Asbian and Brigantian.

Genus *Siphonodendron* McCoy, 1849  
Type species *Siphonodendron pauciradiale* (McCoy, 1844)

**Diagnosis** (modified from Poty, 1981). Fasciculate coral, with corallites having styloform columella. Majors variable in length, that may reach the columella or not. Minors more-or-less developed, reduced to the dissepimentarium or penetrating slightly in the outer tabularium. Dissepimentarium well developed, composed of regular dissepiments, absent in the very small species. Complete or somewhat divided, conical tabulae. They form a channel close to the dissepimentarium. Lateral, non-parricidal increase.

*Siphonodendron intermedium* Poty, 1981  
(Figs 9a-9b)

**Diagnosis** (after Poty, 1981). Phaceloid colonies. Corallites mean diameter 5.2 to 6.2 mm for 21-24 majors (maximum 26). Minors, half of the major in length. Usually two rows of dissepiments.

**Distribution.** Recorded from Cantera Castillo and El Collado.

**Age.** Upper Asbian and lower Brigantian.

*Siphonodendron irregulare* (Phillips, 1836)  
(Fig. 9c)

**Diagnosis** (modified from Poty, 1981). Phaceloid corals with long majors usually reaching the columella, less commonly withdrawn abaxially; minors short, locally penetrating outermost tabularium; columella strongly developed, rarely discontinuous; bifurc morphology locally well expressed in tabularium, tabulae complete or incomplete, gently to steeply elevated adaxially, subhorizontal or concave where majors shortened, small



peripheral plates commonly developed; dissepiments small, strongly convex to globose, usually in one or two rows, rarely up to four rows over short intervals; 20-26 (commonly 21-24) majors at corallite diameter 4-6 mm.

**Distribution.** Recorded in Fuenteovejuna (lower Brigantian) and El Collado.

**Age.** Uppermost Asbian.

*Siphonodendron junceum* (Fleming, 1828)  
(Figs 9d-9e)

**Diagnosis** (after Poty, 1981). Dendroid to phaceloid colonies. Small corallites, 2.3-3 mm in diameter and having 14-18 majors (maximum 20). Dissepiments absent.

**Distribution.** Recorded from Cantera Castillo, El Collado and Sierra de la Estrella 2.

**Age.** Uppermost Asbian, Brigantian.

*Siphonodendron kleffense* (Schindewolf, 1927)  
(Figs 9f-9g)

**Diagnosis** (after Denayer *et al.*, 2011). Dendroid or sub-ceroid colonies. Large corallites 7-9.5 mm in diameter (4-8 mm for the tabularium diameter) having 28-32 majors. Septa long, sinuous in the dissepimentarium, straight in the tabularium, usually connected to the columella. Up to four rows of simple dissepiments. Inner row of dissepiments thickened. Tabulae incomplete. Axial tabulae upturned towards the axis, other tabulae flat or slightly depressed towards the dissepimentarium.

**Distribution.** Recorded from Antolín, El Cañal and La Adelfilla.

**Age.** Brigantian.

*Siphonodendron martini* (Milne-Edwards & Haime, 1851)  
(Figs 9h-9i)

**Diagnosis** (modified from Semenoff-Tian-Chansky & Nudds, 1979; Poty, 1981). Phaceloid corals with long majors commonly reaching columella; minors short, locally penetrating outermost tabularium; columella strongly developed, rarely discontinuous; biform morphology locally well expressed in tabularium, tabulae complete or incomplete, gently to steeply elevated adaxially, small peripheral plates commonly developed; dissepiments small, strongly convex to globose, usually in two-four rows; 23-28 (commonly 23-25) majors at corallite diameter 6-9 mm.

**Distribution.** Recorded from all outcrops in the Guadiato Area, except El Casar, Sierra Palacios, El Couce and Cerro Cabello.

**Age.** Asbian and Brigantian.

*Siphonodendron pauciradiale* (McCoy, 1844)  
(Fig. 9j)

**Diagnosis** (after Poty, 1981). Dendroid to phaceloid colonies. Corallites mean diameter 4 mm for 18-20 majors (maximum 22). One-two rows of dissepiments, rarely up to four.

**Distribution.** Recorded from Peñarroya, La Juliana, El Couce, Sierra de la Estrella 1 and 2 and La Adelfilla.

**Age.** Asbian and Brigantian.

*Siphonodendron scaleberense* Nudds & Somerville, 1987  
(Figs 9k-9m)

**Diagnosis** (after Nudds & Somerville, 1987). Large corallites 13-20 mm in diameter (10-14 mm for the tabularium diameter) and having 30-41 majors and at least two rows of dissepiments.

**Distribution.** Recorded from El Cañal, El Collado and Sierra de la Estrella 1.

**Age.** Brigantian.

*Siphonodendron sociale* (Phillips, 1836)  
(Fig. 9n)

**Diagnosis** (after Poty, 1981). Dendroid *Siphonodendron* with large corallites, 9-11 mm in diameter for 28-31 majors (maximum 34). Minors extending to the dissepimentarium width or shorter. Tabulae conical and incomplete.

**Distribution.** Recorded from Antolín, Sierra Palacios, Cantera Castillo, El Collado, Navacastillo and La Adelfilla.

**Age.** Uppermost Asbian, Brigantian.

Subfamily Diphyphyllinae Dybowski, 1873

Genus *Diphyphyllum* Lonsdale, 1845

Type species *Diphyphyllum concinnum* Lonsdale, 1845

**Diagnosis** (after Poty, 1981). Fasciculate coral with corallites lacking a columella and peripheral, parricidal increase. Short majors. Minors restricted to the dissepimentarium or crossing slightly its inner border. Simple regular dissepiments. Tabulae usually divided; axial tabulae flat, horizontal and having curved borders joining



the subjacent tabulae; periaxial tabulae flat, horizontal or somewhat declined to the dissepimentarium. Small cardinal fossula present.

*Diphyphyllum furcatum* Hill, 1940  
(Fig. 9q)

**Diagnosis** (after Poty, 1981). Corallites 6.2-6.9 mm in diameter and having 23-25 majors (maximum 31), two-four rows of dissepiments.

**Distribution.** Recorded at El Cañal, Sierra Boyera Block, Sierra del Castillo Unit.

**Age.** Brigantian.

*Diphyphyllum gracile* (McCoy, 1851)  
(Figs 9o-9p)

**Diagnosis** (modified from Nudds, 1980). *Diphyphyllum* species with number of majors lower than 20 and one single row of dissepiments.

**Distribution.** Recorded at Peñarroya, olistolite block, San Antonio-La Juliana Unit.

**Age.** Brigantian.

Genus *Solenodendron* Sando, 1976  
Type species *Aulina horsfieldi* Smith & Yü, 1943

**Diagnosis** (modified from Sando, 1976). Fasciculate aulate corals in which the aulos is formed by union of deflected axial ends of majors. Major and minors carinate, carinae of zigzag type. Dissepimentarium regular. Tabulae in aulos ordinarily flat, horizontal; tabulae in tabularium slope downward towards periphery of corallite. Increase lateral in some species, axial (parricidal) in others. Trabecular septa in the dissepimentarium but water-jet fibrous in the tabularium.

*Solenodendron furcatum* (Smith, 1925)  
(Fig. 9r)

**Diagnosis** (modified from Sando, 1976). Subphaceloid *Solenodendron* with mature corallites 3-6 mm in diameter, 18-22 weakly to strongly carinate majors, an aulos about 1/2 the width of the tabularium (1-2 mm), tabulae numbering about 10-12 in 5 mm in the aulos and about 12-15 in the tabularium, and a dissepimentarium 0.5-1 mm wide composed of one or two rows of regular dissepiments. Increase is parricidal, typically quadripartite. Water-jet septal microstructure.

**Distribution.** Recorded from Peñarroya (olistolite), El Cañal, Cantera Castillo and El Collado sections.

**Age.** Upper Asbian and Brigantian.

*Solenodendron horsfieldi* (Smith & Yü, 1943)  
(Fig. 9s)

**Diagnosis** (modified from Sando, 1976). Subphaceloid *Solenodendron* with mature corallites 8-14 mm in diameter, 30-32 weakly to strongly carinate majors, an aulos about 1/2 the width of the tabularium (1.5-3 mm), tabulae numbering about 15 in 5 mm in the aulos and about 20 in 5 mm in the tabularium, and a dissepimentarium 1.5-2.5 mm wide composed of three or more rows of regular dissepiments. Increase is lateral, nonparricidal. Water-jet septal microstructure.

**Distribution.** Recorded from El Collado section, Sierra del Castillo Unit.

**Age.** Lower Brigantian.

Genus *Tizraia* Said & Rodríguez, 2007  
Type species *Tizraia berkhlii* Said & Rodríguez, 2007

**Diagnosis** (after Said & Rodríguez, 2007). Fasciculate lithostrotionid corals lacking axial structure and having transeptal (lonsdaleoid) dissepiments of first and second order. Dissepitheca usually well developed and tabulae mesa-shaped, tabellae commonly form axial and peripheral series. Parricidal increase.

*Tizraia* sp.  
(Fig. 9t)

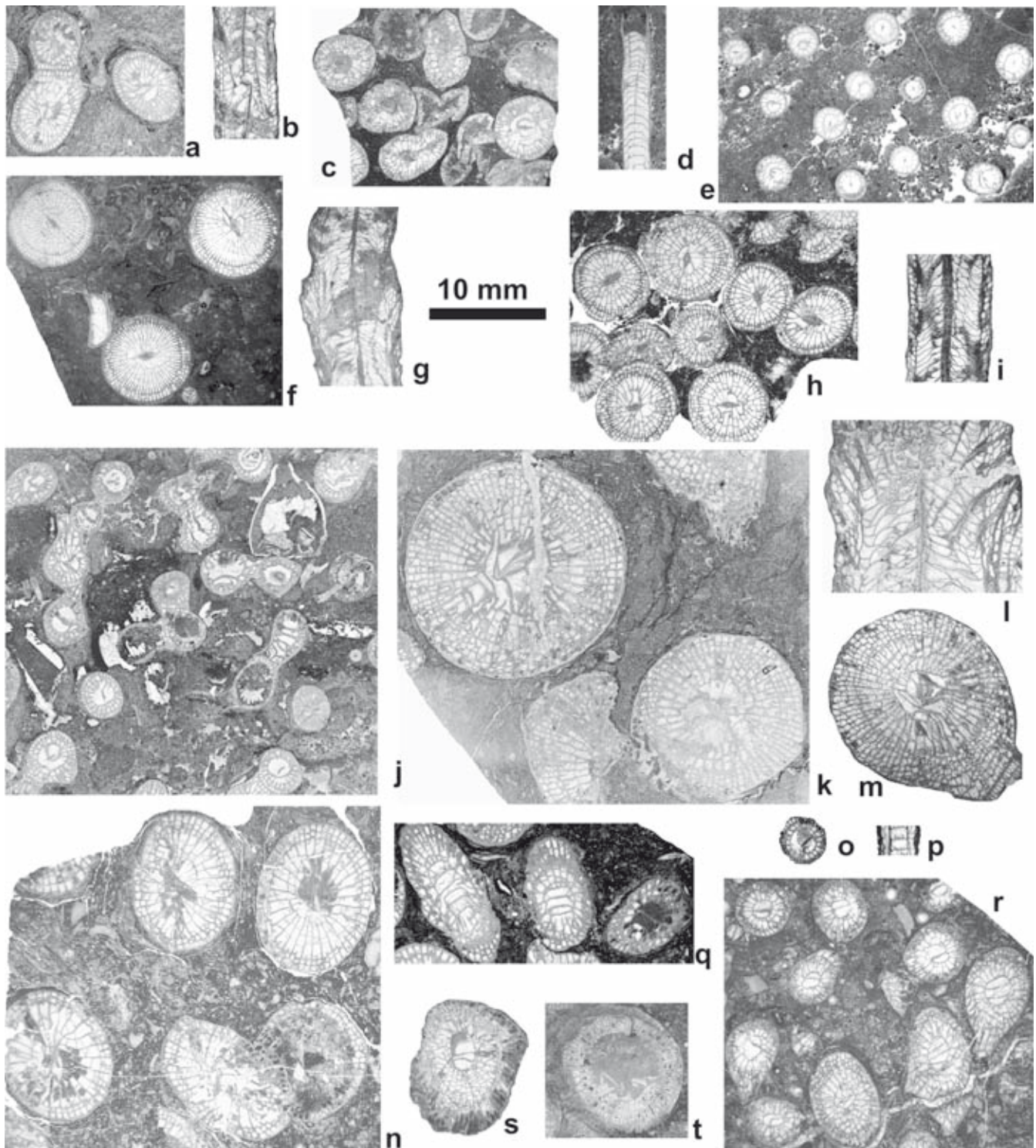
**Distribution.** Recorded from El Cañal, Sierra Boyera Block, Sierra del Castillo Unit.

**Age.** Brigantian.

Suborder LONSDALEIINA Spassky, 1974  
Family **Axophyllidae** Milne-Edwards & Haime, 1851  
Subfamily Axophyllinae Milne-Edwards & Haime, 1851

**Remarks.** For details on the corals belonging to this subfamily synonymies, variability, descriptions, etc., see Rodríguez & Somerville (2014).

Genus *Axophyllum* Milne-Edwards & Haime, 1850  
Type species *Axophyllum expansum* Milne-Edwards & Haime, 1850



**Figure 9.** Fasciculate lithostrotionids. **a-b)** *Siphonodendron intermedium*. Specimen CCS/8-1, Cantera Castillo, **(a)** transverse section; **(b)** longitudinal section. **c)** *Siphonodendron irregulare*. Specimen COL/14-7, El Collado, transverse section. **d-e)** *Siphonodendron junceum*. Specimen CCS/11-1, Cantera Castillo, **(d)** longitudinal section; **(e)** transverse section. **f-g)** *Siphonodendron kleffense*. Specimen CAÑ/1-14, El Cañal, **(f)** transverse section; **(g)** longitudinal section. **h-i)** *Siphonodendron martini*. Specimen PÑR/1-1, Peñarroya, transverse section. **(h)** transverse section; **(i)** longitudinal section. **j)** *Siphonodendron pauciradiale*. Specimen SSE2/18-9, Sierra de la Estrella 2, transverse section. **k-m)** *Siphonodendron scaleberense*. Specimen SSE/14-1, Sierra del Estrella 1. **(k, m)** transverse sections; **(l)** longitudinal section. **n)** *Siphonodendron sociale*. Specimen COL/5-3, El Collado, transverse section. **o-p)** *Diphyphyllum gracile*. Specimen PÑR/2-2, Peñarroya, **(o)** transverse section; **(p)** longitudinal section. **q)** *Diphyphyllum furcatum*. Specimen CAÑ0/17, El Cañal, oblique section. **r)** *Solenodendron furcatum*. Specimen CAÑ0/7, El Cañal, transverse section. **s)** *Solenodendron horsfieldi*. Specimen COL/3-4, El Collado, transverse section. **t)** *Tizraia* sp. Specimen CAÑ0/5, El Cañal, transverse section. Scale bar same for all pictures.



**Diagnosis** (after Rodríguez & Somerville, 2014). Solitary corals. Septa of two orders, thick in periphery, where they may be interrupted in adult stage by transeptal dissepiments. Axial structure composed of thickened, irregular and anastomosing radial lamellae, crossed by a median plate. Conical axial tabellae, concave or subhorizontal periaxial tabellae. Microstructure of the wall is lamellar; septa with fibrous mesoplasm and lamellar stereoplasm.

*Axophyllum kirsopianum* (Thomson & Nicholson, 1876)  
(Fig. 10a)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum* 18 to 22 mm in diameter, 14-16 mm in tabularium diameter, 6-7 mm in axial structure diameter, having 41 to 46 septa of two orders. Majors thick and withdrawn from the axial structure. Low development of lonsdaleoid dissepiments. Inner wall composed of thickened dissepiments. Axial structure large (1/3 of the diameter) and showing thick septal lamellae. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Known from olistolites from El Casar, Fuenteobejuna, Peñarroya, Castillo Belmez, Sierra Palacios, La Juliana-San Antonio, La Adelfilla and Cerro Cabello.

**Age.** Brigantian.

*Axophyllum pseudokirsopianum* Semenoff-Tian-Chansky, 1974  
(Figs 10b-10c)

**Diagnosis** (after Rodríguez & Somerville, 2014). Large *Axophyllum*, having 35-50 septa of two orders in 22-31 mm in diameter, 15-20 mm in tabularium diameter, and 7-13 mm in axial structure diameter. Majors thick in the peripheral part, thinning to the axis. Minors long. Low development of lonsdaleoid dissepiments. Inner wall composed of thickened dissepiments. Axial structure large (1/3 of the diameter) and showing thick septal lamellae. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in olistolites from Fuenteobejuna, Casa de la Calera, Peñarroya, El Cañal, and the Antolín Section, El Castillo Unit.

**Age.** Brigantian.

*Axophyllum mendipense* (Sibly, 1906)  
(Fig. 10d)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum*, having 25-35 septa of two orders in 10-20 mm in diameter, 8-15 mm in tabularium diameter, and

4-8 mm in axial structure diameter. Majors thick. Minors short, form crests on the dissepiments and wall. Low development of lonsdaleoid dissepiments in a narrow dissepimentarium. Inner wall composed of thickened dissepiments. Axial structure 1/3 to 1/4 of the diameter. It shows a dense net composed of thick septal lamellae and conical axial tabellae. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in sections of Antolín, El Couce and El Collado, El Castillo Unit.

**Age.** Brigantian.

*Axophyllum densum* (Ryder, 1930)  
(Figs 10e-10f)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum*, having 20-34 septa of two orders in 5-15 mm in diameter, 4-13 mm in tabularium diameter, and 2-3 mm in axial structure diameter. Majors almost reaching the axial structure. Thick septal stereozone in young stages that is interrupted by a few lonsdaleoid dissepiments in adult stage. Axial structure 1/3 to 1/5 of the diameter. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in Cantera Castillo, El Collado, El Cañal, and Peñarroya sections.

**Age.** Upper Asbian and lower Brigantian.

*Axophyllum vauhani* (Salée, 1913)  
(Fig. 10g)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum*, having 25-36 septa of two orders in 12-16.5 mm in diameter, 7-10 mm in tabularium diameter, and 3-4 mm in axial structure diameter. Majors reaching or almost reaching the axial structure. Minors short to absent. Dissepimentarium showing moderate development of the lonsdaleoid dissepiments. Axial structure 1/3 to 1/5 of the diameter. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in El Collado, El Casar and Peñarroya sections.

**Age.** Upper Asbian and lower Brigantian.

*Axophyllum tazoultense* Semenoff-Tian-Chansky, 1974  
(Fig. 10h)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum*, having 40-47 septa of two orders in 14-20 mm in diameter, 12-14 mm in tabularium diameter, and 7-8 mm in axial structure diameter. Majors reaching or



almost reaching the axial structure. Minors penetrating into the tabularium. Dissepimentarium showing interseptal dissepiments, lonsdaleoid dissepiments if present (eroded in the type). Axial structure large, with irregular median plate; densely packed in the periphery, loosely packed in the axis. Axial tabellae gently declined towards the periphery in the axis, but steeply declined in the periphery. Periaxial tabellae concave and declined towards the axis. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in El Casar.

**Age.** Brigantian.

*Axophyllum spiralum* Rodríguez & Somerville, 2014  
(Fig. 10i)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum*, having 30-38 majors in 10-20 mm in diameter, 8-18 mm in tabularium diameter, and 4-8 mm in axial structure diameter. Majors reaching or almost reaching the axial structure. Minors short, penetrating slightly into the tabularium. Narrow dissepimentarium only developed in adult stages showing lonsdaleoid dissepiments and one row of thickened interseptal dissepiments that form a conspicuous inner wall. Axial structure large (1/2 to 1/3 of the diameter), with irregular median plate, thick, anastomosed and twisted radial lamellae and thin conical tabellae. Periaxial tabellae concave and declined towards the axis. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** El Casar, Fuenteobejuna and Peñarroya sections.

**Age.** Brigantian.

*Axophyllum cozari* Rodríguez & Somerville, 2014  
(Figs 10j-10k)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Axophyllum*, having 34-39 majors in 24-32 mm in diameter, 16-18 mm in tabularium diameter, and 7-9 mm in axial structure diameter. Majors reaching or almost reaching the axial structure. Minors long, penetrating clearly into the tabularium. Wide lonsdaleoid dissepimentarium and one to three rows of interseptal dissepiments; the inner one forms a conspicuous inner wall. Axial structure 1/3 to 1/4 of the alar diameter, with strongly thickened median plate, thick, anastomosed and twisted radial lamellae and conical tabellae. Periaxial tabellae concave and declined to the axis. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Antolín Section, Córdoba Province, Sierra Boyera Block.

**Age.** Brigantian.

Genus *Gangamophyllum* Gorsky, 1938

Type species *Gangamophyllum boreale* Gorsky, 1938

**Diagnosis** (modified from Semenoff-Tian-Chansky, 1974). Solitary conical corals having a peripheral zone of large dissepiments sometimes lonsdaleoid. Inner wall that is reduced in adult stages. Web-like axial structure without median plate, composed of radial lamellae and axial tabellae. Large dissepiments very declined towards the axis. Periaxial tabellae concave and also declined towards the axis. Domical axial tabellae. Fibronormal mesoplasm, lamellar stereoplasm.

*Gangamophyllum gorskyi* Vassiljuk, 1960  
(Fig. 10l)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Gangamophyllum* 20 to 25 mm in diameter, 13-15 mm in tabularium diameter, 7.5-9 mm in axial structure diameter, having 36 to 40 septa of two orders. Majors thick and in contact with the axial structure. Dissepiments mainly regular to herringbone. Conspicuous inner wall composed of thickened dissepiments. Axial structure large (1/3 of the diameter), showing thick, slightly twisted septal lamellae. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in Fuenteobejuna, Peñarroya, Sierra Palacios, Adelfilla Quarry and Cerro Cabello.

**Age.** Brigantian.

*Gangamophyllum mosquense* Dobrolyubova, 1952  
(Fig. 10m)

**Diagnosis** (after Rodríguez & Somerville, 2014). *Gangamophyllum* 28 to 34 mm in diameter, 11-15 mm in tabularium diameter, 5-8 mm in axial structure diameter, having 28 to 34 septa of two orders. Majors thick to moderately thick and long, almost reaching the axial structure. Minors mainly small crests on the inner wall. Wide lonsdaleoid dissepimentarium composed of large elongated dissepiments. Inner row thickened to form an inner wall. Axial structure large (about 1/3 of the diameter), showing low density of thin radial lamellae and axial tabellae. Fibrous septal mesoplasm, lamellar stereoplasm.

**Distribution.** Recorded in El Casar and El Collado.

**Age.** Brigantian.

Genus *Morenaphyllum* Rodríguez & Somerville, 2014  
Type species *Morenaphyllum antolinense* Rodríguez & Somerville, 2014

**Diagnosis.** Axophyllinae with quite a small axial structure joined to a thick and long cardinal septum and having an irregular median plate, which is thick, but discontinuous, a few radial lamellae and conical tabellae. Conspicuous inner wall composed of lamellar thickenings. Wide transeptal dissepimentarium. Mesoplasm composed of bundles of microlamellae that comprise pseudofibrous structures that produce characteristic denticulations on the wall and transeptal dissepiments. Lamellar stereoplasm.

*Morenaphyllum antolinense* Rodríguez & Somerville,  
2014  
(Figs 10n-10p)

**Diagnosis.** *Morenaphyllum* having a thick wall and low development of stereoplastic thickenings. 30 to 40 majors in 18 to 28 mm in adult stages. Axial structure 2.5-5 mm, being 1/5 to 1/7 of the diameter.

**Location, horizon and age.** Antolín section, located near the coal mine of Antolín, 2 km south from Peñarroya. Sierra Boyera Block, El Castillo Unit.

**Age.** Brigantian.

*Morenaphyllum boyerense* Rodríguez & Somerville,  
2014  
(Figs 10q-10r)

**Diagnosis.** *Morenaphyllum* having 30 to 34 majors in 18 to 20 mm in diameter, counter septum commonly joined to the axial structure, strong stereoplastic thickenings and irregular inner wall. Axial structure 2-3 mm being 1/6 of the diameter.

**Distribution.** Antolín section, located near the coal mine of Antolín, 2 km south from Peñarroya. Sierra Boyera Block, El Castillo Unit.

**Age.** Brigantian.

*Morenaphyllum* sp.  
(Fig. 10s)

**Distribution.** Fuenteovejuna outcrop. Sierra Boyera Block, El Castillo Unit.

**Age.** Brigantian.

Family **Geyerophyllidae** Grabau, 1930  
Genus *Amygdalophylloides* Dobrolyubova & Kabakovich, 1948  
Type species *Amygdalophylloides ivanovi* Dobrolyubova, 1937

**Diagnosis** (modified from de Groot, 1963). Small, solitary geyerophyllid corals with septa typically extending from the epitheca; dissepimentarium narrow and mainly interseptal; axial structure formed chiefly by the dilated and vertically elongated axial end of the cardinal septum, that may be reinforced by some septal lamellae and tabellae.

*Amygdalophylloides anticuum* Rodríguez & Said, 2009  
(Figs 10t-10v)

**Diagnosis** (after Rodríguez & Said, 2009). Small, solitary, ceratoid corals having 25 to 28 majors and 5.5 to 8 mm in diameter. Thin septa that almost reach the axial structure. This is a large, massive, oval column that may show irregular borders. Well developed clinotabulae, deeply declined towards the column. Septal stereozone in young stages, which is substituted in adult stages by one or two rows of mainly transeptal dissepiments. Septal microstructure composed of small fibres grouped in fascicles; lamellar microstructure of wall and thickenings of septa and axial column.

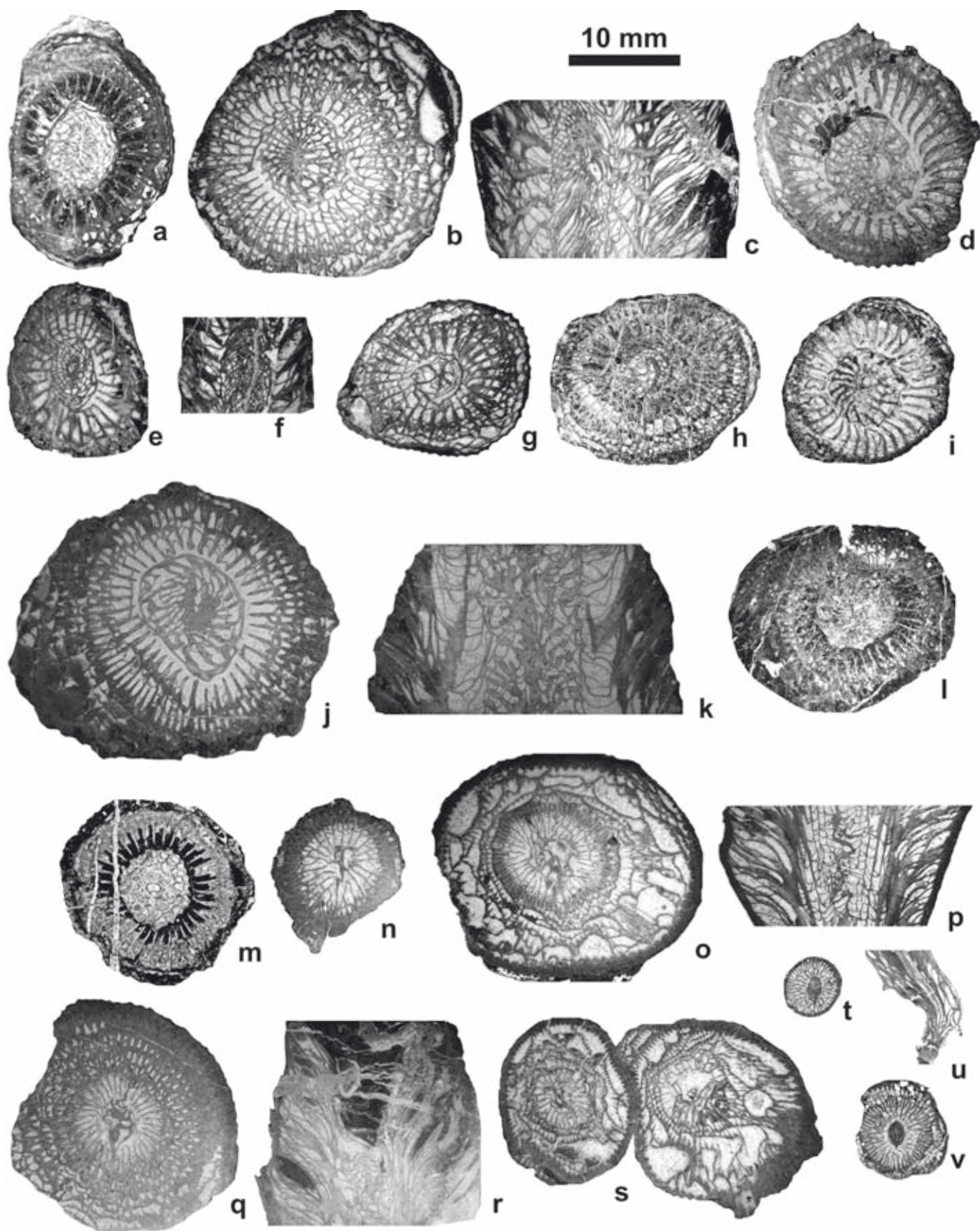
**Distribution.** El Casar, Fuenteovejuna, Peñarroya, Casa de la Calera, El Cañal, San Antonio-La Juliana Unit olistolites and Sierra Boyera Block (Sierra del Castillo Unit).

**Age.** Brigantian.

Order HETEROCORALLIA Schindewolf, 1941  
Family **Heterophylliidae** Dybowski, 1873  
Genus *Hexaphyllia* Stuckenberg, 1904  
Type species *Hexaphyllia prismatica* Stuckenberg, 1904

**Diagnosis** (after Cossey, 1997). Elongate, cylindrical or prismatic heterocorals with up to six sides and a maximum of six septa, which meet at or near the axis. The peripheral edges of the septa may thicken and project through the wall to form longitudinal ridges or costae along the side of the corallite. The costae may be adorned with tubercles or spines which curve distally in the direction of corallite growth. Whilst the internal structure of the costae, spines and tubercles appears to be continuous with the septa, their external structure appears to form an extension of the tabulotheca. The tabulae are complete and slightly domed structures near the axis, but turn downwards peripherally and fuse together between the distal edges of the septa to form the tabulotheca. Corallite diameters and tabulae spacing values are continuously variable parameters.

*Hexaphyllia marginata* (Fleming, 1823)  
(Fig. 11a)





**Diagnosis** (after Cossey, 1997). As for the genus.

**Distribution.** Recorded from Antolín, Cantera Castillo and El Collado, Sierra del Castillo Unit.

**Age.** Asbian-Brigantian.

Genus *Heterophyllia* McCoy, 1849

Type species *Heterophyllia grandis* McCoy, 1849

**Diagnosis** (modified from Poty, 1981). Solitary corals, sub-cylindrical, very long, with crests sometimes prolonged by spines. Septa grouped in fascicles, crossing the external wall. Septa divided dichotomously from the axial oblique plate. Tabulae strongly domical. Absence of dissepiments. Absence of calice.

*Heterophyllia ornata* McCoy, 1849  
(Fig. 11b)

**Diagnosis** (modified from Poty, 1981). *Heterophyllia* that may reach several tens of cm in length but does not exceed 4.2 mm in diameter and having a maximum of 30 septa.

**Distribution.** Recorded from Antolín, El Cañal and El Collado, Sierra del Castillo Unit.

**Age.** Brigantian.

Subclass TABULATA Milne-Edwards & Haime, 1850  
Order SYRINGOPORIDA Sokolov, 1947  
Family **Syringoporidae** de Fromentel, 1861  
Subfamily Syringoporinae de Fromentel, 1861  
Genus *Syringopora* Goldfuss, 1826  
Type species *Syringopora ramulosa* Goldfuss, 1826

**Diagnosis** (after Tchudinova, 1986). Colony fasciculate, with closely spaced, occasionally contiguous cylindrical corallites. Corallites long, usually more or less curved, but

on the whole parallel to each other. Corallite wall externally covered with concentrically rugose or smooth epitheca. Microstructure of wall lamellar. Corallites connected by tubules that are usually horizontal and irregularly arranged. Tabulae infundibuliform, with or without axial syrinx. Septal elements appearing as longitudinal rows of spinules. Microstructure of lamellar spinules, less commonly trabecular (monacanth, holacanth). Increase lateral or solenial (offsets appear on connecting tubules).

**Remarks.** The auloporoids from Guadiato Area have been described by Coronado & Rodríguez (2014) in open nomenclature, awaiting a more detailed revision that is in preparation. Thus, all species are referred in this paper to the nomenclature given in the cited article (sp. A, B, C, etc.).

*Syringopora* sp. B (Coronado & Rodríguez, 2014)  
(Figs 11c-11d)

**Distribution.** Recorded from Antolín, El Cañal and La Adelfilla, Sierra del Castillo and San Antonio-La Juliana units.

**Age.** Brigantian.

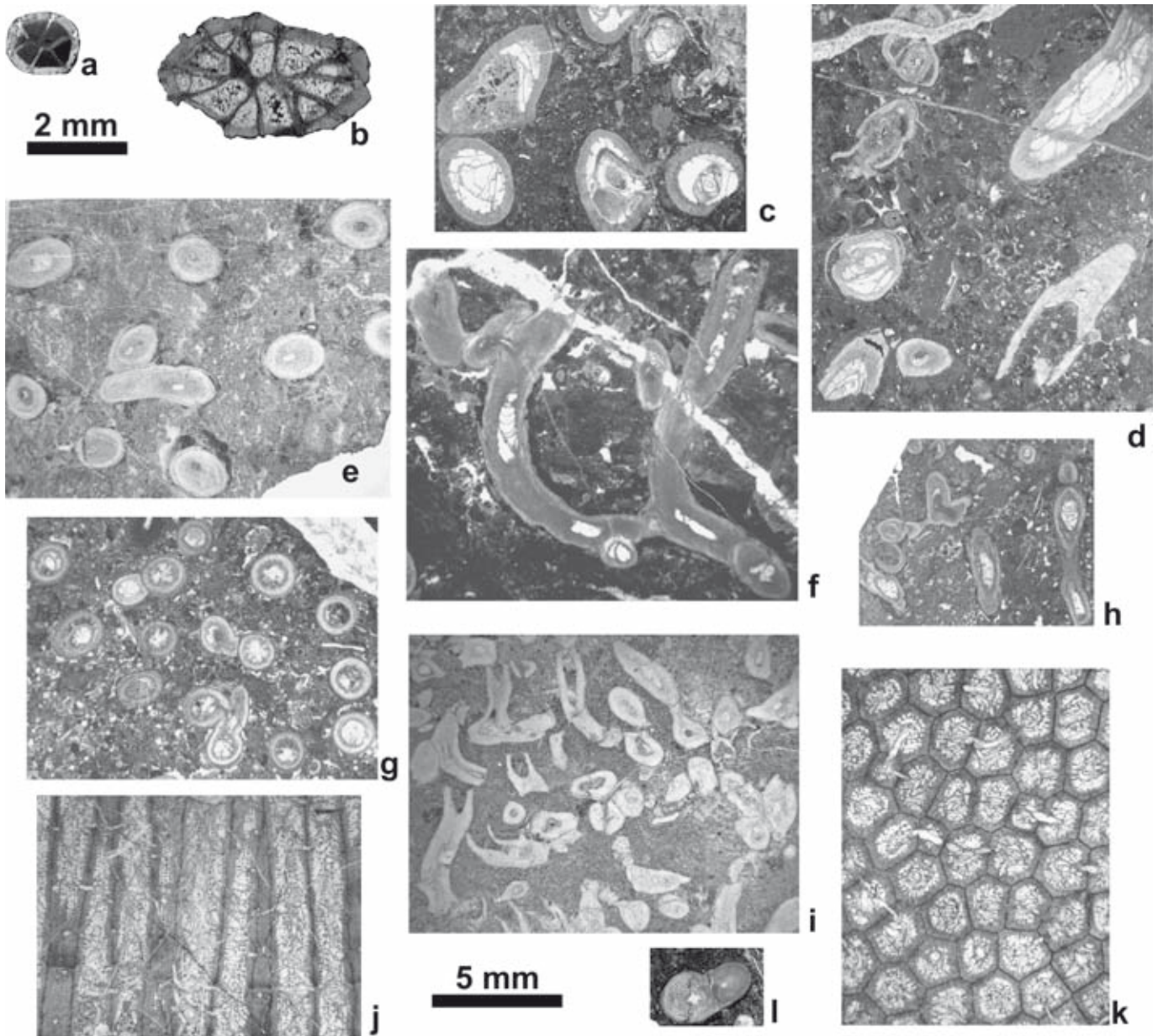
Family **Multithecoporidae** Sokolov, 1950

Genus *Multithecopora* Yoh, 1927

Type species *Multithecopora penchiensis* Yoh, 1927

**Diagnosis** (after Tchudinova, 1986). Colonies fasciculate, with cylindrical corallites bearing well-defined wrinkled epitheca. Sclerenchyme of wall lamellar and so thick that lumen of corallites reduced to 1/3-1/5 of diameter; epitheca fibrous. Connecting tubules thin, sparse; mural pores developed where corallites contact. Tabulae thin, complete, horizontal, concave, sparse, in places absent. Septal spinules well developed or lacking. Increase interstitial, more commonly lateral.

**Figure 10.** Axophyllidae and Geyerophyllidae. **a)** *Axophyllum kirsopianum*. Specimen CS/11-4, El Casar, transverse section. **b-c)** *Axophyllum pseudokirsopianum*. Specimen PNR/4-14, Peñarroya, **(b)** transverse section; **(c)** longitudinal section. **d)** *Axophyllum mendipense*. Specimen COL/7-8, El Collado, transverse section. **e-f)** *Axophyllum densus*. Specimen CCS/11-9, Cantera Castillo, **(e)** transverse section; **(f)** longitudinal section. **g)** *Axophyllum vughani*. Specimen CS/14-15, El Casar, transverse section. **h)** *Axophyllum tazoultense*. Specimen CS/12-3, El Casar, transverse section. **i)** *Axophyllum spirale*. Specimen CS/15-2, El Casar, transverse section. **j-k)** *Axophyllum cozari*. Specimen ANT2/1-39, Antolín, **(j)** transverse section; **(k)** longitudinal section. **l)** *Gangamophyllum gorskyi*. Specimen ADF/5-11, La Adelfilla, transverse section. **m)** *Gangamophyllum mosquense*. Specimen CS/25-5, El Casar, transverse section. **n-p)** *Morenaphyllum antolinense*. **(n)** Specimen ANT2/1-1, Antolín, transverse section in young stage. **(o-p)** Specimen ANT2/2-52, Antolín, transverse and longitudinal sections. **q-r)** *Morenaphyllum boyerense*. Specimen ANT2/2-12, Antolín, **(q)** transverse section; **(r)** longitudinal section. **s)** *Morenaphyllum* sp. Specimen FBJ/35, Fuentebejuna, transverse section. **t-v)** *Amygdalophylloides anticuum*. **(t, v)** Specimen CS/7-36, El Casar, transverse sections in young and adult stages respectively. **(u)** Specimen CS/7-6, El Casar, longitudinal section. Scale bar same for all pictures.



**Figure 11.** Heterocorallia and Tabulata. **a)** *Hexaphyllia marginata*. Specimen CAÑO0/22, El Cañal, transverse section. **b)** *Heterophyllia ornata*. Specimen CAÑO/25, El Cañal, transverse section. **c-d)** *Syringopora* sp. B from ANT, Antolín, **(c)** transverse sections. **(d)** transverse and oblique sections. **e-f)** *Multithecopora* sp. A from ANT, Antolín, **(e)** transverse sections; **(f)** longitudinal sections. **g-h)** *Multithecopora* sp. B from FBJ, Fuenteovejuna, **(g)** transverse section; **(h)** oblique and longitudinal sections. **i)** *Multithecopora* sp. C. from COL, El Collado, transverse and longitudinal sections. **j-k)** *Roemeripora* sp. from FBJ, Fuenteovejuna. **(j)** longitudinal section; **(k)** transverse section. **l)** *Cladochonus* sp. from COL, El Collado, oblique section. 2 mm scale bar for heterocorals, 5 mm scale bar for tabulates.

*Multithecopora* sp. A (Coronado & Rodríguez, 2014)  
(Figs 11e-11f)

**Distribution.** Recorded from Fuenteovejuna, Antolín, El Cañal, El Collado and Sierra de la Estrella 1, Sierra del Castillo and San Antonio-La Juliana units.

**Age.** Asbian-Brigantian.

*Multithecopora* sp. B (Coronado & Rodríguez, 2014)  
(Figs 11g-11h)

**Distribution.** Recorded from Fuenteovejuna, Antolín and El Cañal, Sierra del Castillo and San Antonio-La Juliana units.

**Age.** Asbian-Brigantian.

*Multithecopora* sp. C (Coronado & Rodríguez, 2014)  
(Fig.11i)

**Distribution.** Recorded from El Collado, Sierra del Castillo unit.

**Age.** Lowermost Brigantian.

Family **Syringolitidae** Waagen & Wentzel, 1886  
Genus *Roemeripora* Kraicz, 1934  
Type species *Roemeripora bohémica* (Pocta, 1902)

**Diagnosis** (after Hill, 1981). Corallum cerioid; corallites prismatic or, when slightly divergent, cylindrical; peripheral stereozone transversely wrinkled externally where corallites are not tightly adpressed; septal spines holacanthine, arranged in lamellar sclerenchyma of stereozone in numerous radial longitudinal rows and on tabulae; tabulae thin, complete, or more commonly incomplete, horizontal, concave or infundibuliform, and grouped in relation to pore-canals (or to connecting tubules that lie on the external wrinklins of the wall); offsets arise from openings of pore-canals.

*Roemeripora* sp.  
(Figs 11j-11k)

**Distribution.** Recorded from Fuenteobejuna, San Antonio-La Juliana unit.

**Age.** Brigantian.

Family **Pirgiidae** de Fromentel, 1861  
Genus *Cladochonus* McCoy, 1847  
Type species *Cladochonus tenuicollis* McCoy, 1847

**Diagnosis** (after Hill, 1981). Proximal parts of corallum prostrate, annular when externally attached to crinoid stem; distal parts of corallum erect branches that may torque; corallites commonly opening through wall near base of calice of parent; wall moderately thick, in some states of preservation including holacanthine spinules; in other states, growth lamellae of sclerenchyma of wall may be slightly separate and connected by granules; tabulae absent or sparse.

*Cladochonus* sp.  
(Fig. 11l)

**Distribution.** Recorded from El Collado, Sierra del Castillo unit.

**Age.** Lowermost Brigantian.

### 3. DISCUSSION

#### 3.1. Diversity and abundance

The number of species illustrated in this inventory (69) is not the result of a really high coral abundance and/or diversity in the Guadiato Area. The studied area covers more than 150 km<sup>2</sup> of which about 30 km<sup>2</sup> are limestones. In addition, it comprises a time span of more than 5 million years in a subtropical region (Golonka, 2012). Comparing with recent parameters, the presence of several hundreds of coral species could be expected. There are many reasons for the reduced recorded diversity:

1) The coral record is not complete and some species that lived in that area may be not preserved.

2) Our coral taxonomy is basically morphologic. The corals are primitive invertebrates in which many homeomorphic processes take place. The identification of several true species as a single morphological species is highly probable (Fedorowski, 2010).

3) Sedimentation took place in a syntectonic environment. The Variscan Orogeny produced the collision of Gondwana and Laurasia and the Iberian plate was located in the middle of that collision (Wagner, 1999, 2004). The most abundant sediments in the Guadiato Area are siliciclastics. In many cases, limestones are interbedded with shales and sandstones; the siliciclastic inputs created environments not favourable for corals. In addition, tectonic movements also destroyed part of the carbonate platforms, as proved by the presence of Viséan limestone olistolites in Serpukhovian rocks of the San Antonio-La Juliana Unit (Gabaldón *et al.*, 1985a; Cózar & Rodríguez, 1999a).

However, the number of species recorded for the same time span is not much lower than those from other well-known regions. The inventory of Mississippian rugose corals from Belgium (Denayer *et al.*, 2011), provide an excellent database for comparison. The stratigraphic interval, comprises the coral zones RC6 to RC8 (Poty, 1984; Poty *et al.*, 2006; Denayer *et al.*, 2011) in Belgium and the coral zones 1 to 5 (Rodríguez & Somerville, 2007). For that stratigraphic interval, 74 rugose coral species have been recorded in Belgium and 61 in the Guadiato Area. Taking into account that the Belgian outcrops are by far more extensive, were located closer to the Equator and have been studied for many more years than those from the Guadiato, the difference is not significant. No similar synthesis or inventories have been done in other regions, but 43 rugose coral species have been recorded by Mitchell (1989) in Britain without taking into account the zaphrentid corals and only with his own data (based mostly on Viséan taxa). The degree of diversity in all those areas from the western Palaeotethys seems to be similar.



Comparisons with other areas can not be achieved, because no detailed inventories have been done. However, the different degree of knowledge of Viséan coral records in regions such as Poland (Fedorowski, 1968, 1971, 1975; Khoa, 1977, etc.), Donets Basin (Vassiljuk, 1960), Béchar and Tindouf basins in Sahara (Semenoff-Tian-Chansky, 1974, 1985; Aretz, 2011; Rodríguez *et al.*, 2013) and Azrou-Khenifra Basin in Morocco (Said *et al.*, 2007, 2013; Aretz & Herbig, 2010) give similar results when the coral assemblages have been extensively studied.

The conclusion is that the coral diversity in the Guadiato Area is standard for the western Palaeotethys. However, very few outcrops and/or beds yielded a high number of species (Table 1). The exceptions to that rule are of two types: 1) Outcrops such as Antolín (19 species recorded) and El Cañal (23 species recorded) where the corals are located mainly in debris coming from shallow platforms, but sedimented in deeper water facies. These outcrops comprise sediments coming from different environments (reefs, calcareous shoals, shallow and middle platform), that are reworked and concentrated. The assemblages are highly diverse, because they are mixed associations that comprise elements of several environments. 2) Thick sections that comprise more than 100 metres of limestones, such as Cantera Castillo (17 species), El Collado (32 species) and Sierra de la Estrella 1 (19 species). They thus correspond to temporal accumulations.

Corals are mostly scarce in the Guadiato Area. They are abundant only in some precise beds, related to reefal development. Antolín and El Cañal debris show conspicuous concentration of corals, where lithostrotionids and syringoporoids are dominant. El Collado-2 bed (Rodríguez *et al.*, 2007) is a coral biostrome partially reworked by a storm. No other bed shows a high abundance of corals. They are also common in some beds at Sierra de la Estrella, in La Adelfilla, in Fuenteovejuna, Peñarroya and in El Casar. It is a result of the scarcity of appropriate environments for the development of corals.

The level of endemism is low, as it is usual in the western Palaeotethys. Two genera (*Espielia* and *Morenaphyllum*) have been described for the first time in the Viséan from the Guadiato Area, but at least one of them (*Espielia*) has been subsequently found in South France (Aretz, 2002) North Africa (Aretz, 2011) and Turkey (Denayer, 2012). A possible species of *Morenaphyllum* was previously described by Bykova (1966) under the generic name of *Carcinophyllum*. Seven species have been first described in the Guadiato Area (*Amygdalophylloides anticuum*, *Axophyllum cozari*, *Axophyllum julianaense*, *Axophyllum spirulum*, *Espielia columellata*, *Morenaphyllum antolinense* and *Morenaphyllum boyerense*). As one of them has been also recorded in other areas, the level of endemism is lower than 10%.

## 3.2. Environments

The coral assemblages from the Guadiato Area show clear differences in different environments. In such a large region and with so many outcrops, very different environments where corals lived have been recorded, from very shallow-water platforms and reefs to deeper water middle ramps. The analysis of the environments where the coral lived in the Guadiato Area was achieved by Rodríguez & Somerville (2007) and it will be not repeated here. A more general analysis on Mississippian coral habitats was achieved by Aretz (2010). A summary of the environments of each outcrop including main microfacies is shown in Table 2.

The outcrops located in the different blocks of the Sierra del Castillo Unit are usually sections that comprise various facies and coral assemblages. They are diverse environments recorded in those outcrops:

### 3.2.1. Sierra del Castillo Unit

Most corals recorded in outcrops from the Sierra Boyera Block (Casa de la Calera, Antolín, El Cañal and Sierra Boyera) are located in debris sedimented in ramp/talus that comprise assemblages coming from shallower-water facies (Cózar & Rodríguez, 2000; Rodríguez & Rodríguez-Curt, 2002), which include shallow platforms, reefs and shoals. The outcrop from El Couce Block shows clearly a *Cyathaxonia* fauna assemblage, typical of a deeper water distal shelf or slope. The Assemblages from the Sierra del Castillo Block comprise thick sequences, with very diverse environments (Cózar & Rodríguez, 1999c; Rodríguez *et al.*, 2007). The Cantera Castillo and El Collado sections comprise mainly shallow shelf environments, whereas Sierra de la Estrella 1 and 2 comprise mainly middle and distal deeper water ramp facies including microbial mud-mounds (Cózar *et al.*, 2003).

### 3.2.2. San Antonio-La Juliana Unit

All Viséan outcrops in that unit represent olistoliths that show a very homogeneous facies; bioclastic wackestones/packstones representing shallow platform environments, and ooidal grainstones representing shoals. It is also the case of the olistoliths mentioned here (Castillo Belmez, Sierra Palacios, Burjadillo, La Juliana, La Adelfilla and Cerro Cabello).

### 3.2.3. North-western outcrops

The outcrops located in the north-western end of the Guadiato Area (Peñarroya, Fuenteovejuna; Fig. 2) and its prolongation (El Casar; Fig. 3) are bounded by faults and can not be regarded as part of either the San Antonio-La Juliana or Sierra del Castillo units. Their positioning seems to indicate that they are a prolongation of the line of olistoliths, but the coral assemblages are closer to

**Table 2.** Environmental parameters of the studied outcrops. Abbreviation RCA is Rugose Coral Assemblages of Somerville & Rodríguez (2007).

| Outcrops and units                  | RCA<br>(S & R 007) | Main<br>microfacies                       | Main coral taxa  | Abundance       | Transport<br>index | Observations               |
|-------------------------------------|--------------------|---|--|-----------------|--------------------|----------------------------|
| El Casar                            | RCA2               | Packstone                                 | <i>Axophyllum</i> , <i>Palaeosmilia</i> ,<br><i>Amygdalophylloides</i>   | Moderate        | Moderate           |                            |
| Fuenteobejuna                       | RCA2               | Packstone,<br>Grainstone                  | <i>Axophyllum</i> , <i>Syringoporoids</i> ,<br><i>Amygdalophylloides</i> | Moderate        | Moderate           |                            |
| Peñarroya                           | RCA2               | Packstone,<br>Grainstone                  | <i>Axophyllum</i> , <i>Palaeosmilia</i> ,<br><i>Amygdalophylloides</i>   | Low to moderate | Moderate           |                            |
| Casa de la Calera                   | RCA2               | Packstone,<br>Boundstone                  | <i>Axophyllum</i> , <i>Palaeosmilia</i> ,<br><i>Amygdalophylloides</i>   | Low to moderate | High               |                            |
| Antolín 1                           | RCA7               | Rudstone,<br>Boundstone                   | <i>Siphonodendron</i> , <i>Lithostrotion</i> ,<br><i>Syringoporoids</i>  | High            | Very high          | Reworked<br>assemblage     |
| Antolín 2                           | RCA5               | Packstone                                 | <i>Axophyllum</i> , <i>Siphonodendron</i>                                | High            | Moderate           |                            |
| Antolín 3                           | RCA6               | Wackestone,<br>Marls                      | <i>Siphonophyllia</i> , <i>Caninophyllum</i>                             | Low             | Moderate           |                            |
| El Cañal                            | RCA7<br>RCA2       | + Boundstone,<br>Rudstone                 | <i>Siphonodendron</i> , <i>Axophyllum</i> ,<br><i>Syringoporoids</i>     | Moderate        | High               | Mixed and<br>reworked ass. |
| Sierra Boyera                       | RCA2               | Wackestone,<br>Packstone                  | <i>Clisiophyllum</i> , <i>Palaeosmilia</i>                               | Low             | High               | Reworked<br>assemblage     |
| Castillo Belmez                     | RCA5               | Wackestone,<br>Packstone                  | <i>Palaeosmilia</i> , <i>Siphonodendron</i>                              | Low             | Moderate           | Olistolith                 |
| Sierra Palacios                     | RCA5<br>RCA2       | + Wackestone,<br>Packstone,<br>Grainstone | <i>Axophyllum</i> , <i>Siphonodendron</i>                                | Low             | Low                | Olistolith                 |
| El Burjádillo                       | RCA5               | Wackestone,<br>Packstone                  | <i>Siphonodendron</i> , <i>Clisiophyllum</i>                             | Low             | Low                | Olistolith                 |
| La Juliana                          | RCA5               | Wackestone,<br>Packstone                  | <i>Siphonodendron</i> , <i>Axophyllum</i>                                | Moderate        | Low                | Olistolith                 |
| El Couce                            | RCA8               | Wackestone                                | <i>Cyathaxonia</i> , <i>Rotiphyllum</i> ,<br><i>Ufimia</i>               | Moderate        | Low                |                            |
| Cantera Castillo (1-4, 6,<br>14-15) | RCA2               | Wackestone,<br>Packstone                  | <i>Palaeosmilia</i> , <i>Axophyllum</i>                                  | Moderate        | Moderate           |                            |
| Cantera Castillo (8-10)             | RCA1               | Packstone                                 | <i>Aulophyllum</i> , <i>Clisiophyllum</i>                                | Moderate        | Low                |                            |
| Cantera Castillo (11-13)            | RCA3               | Packstone,<br>Rudstone                    | <i>Siphonodendron</i>  | High            | Moderate           | Biostrome                  |
| El Collado (1-3)                    | RCA3               | Packstone,<br>Rudstone                    | <i>Siphonodendron</i>  | High            | Moderate           | Biostrome                  |
| El Collado (4-6)                    | RCA2               | Wackestone,<br>Packstone                  | <i>Palaeosmilia</i> , <i>Axophyllum</i>                                  | Moderate        | Moderate           |                            |
| El Collado (7-13)                   | RCA5               | Wackestone,<br>Packstone                  | <i>Siphonodendron</i> , <i>Dibunophyllum</i>                             | Moderate        | Moderate           |                            |
| Navacastillo                        | RCA5               | Wackestone,<br>Packstone                  | <i>Siphonodendron</i> , <i>Dibunophyllum</i>                             | Low             | Moderate           |                            |
| S. Estrella 1 (10-18)               | RCA8               | Wackestone,<br>Marls                      | <i>Rotiphyllum</i> , <i>Cyathaxonia</i> ,<br><i>Rylstonia</i>            | Moderate        | Low                |                            |
| S. Estrella 1 (8-9)                 | RCA6               | Wackestone,<br>Boundstone                 | <i>Siphonodendron</i> , <i>Siphonophyllia</i> ,<br><i>Syringoporoids</i> | Low             | Low                |                            |
| S. Estrella 2                       | RCA6               | Wackestone,<br>Packstone                  | <i>Siphonodendron</i>  | Low             | Low                |                            |
| La Adelfilla                        | RCA5<br>RCA7       | + Packstone,<br>Grainstone                | <i>Siphonodendron</i> , <i>Axophyllum</i>                                | Moderate/High   | High /<br>moderate | Mixed facies<br>Olistolith |
| Cerro Cabello                       | RCA5               | Wackestone,<br>Packstone                  | <i>Axophyllum</i> , <i>Lithostrotion</i>                                 | Low             | Moderate           | Olistolith                 |

those of the Sierra Boyera Block. The dominant facies are bioclastic wackestones/packstones and ooidal grainstones (Cózar & Rodríguez, 1999d; Cózar *et al.*, 2007; Rodríguez & Said, 2009), such as in most olistoliths, but the abundance and diversity of corals is similar to that in Antolín and El Cañal. They represent mainly shallow platforms and ooidal shoals.

### 3.3. Palaeogeography

The studied outcrops are located in two different tectono-stratigraphic units that are separated by strike-slip faults (Wagner, 1999; Simancas *et al.*, 2001), which produced relative movement that could reach more than 100 km along strike. Consequently, the current position of the different outcrops in the Guadiato Area is very different from that when Viséan sedimentation occurred. The analysis of the coral assemblages allows the identification of some trends that may help to identify the palaeogeographic relationships between the different outcrops.

The outcrops can be divided in three main groups and six sub-groups (Table 1, dark grey). The Sierra del Castillo Unit constitutes the first group of outcrops. It comprises three blocks (or subgroups), the Sierra Boyera Block (Casa de la Calera, Antolín, El Cañal and Sierra Boyera outcrops, SBB), the Couce Block (Couce outcrop) and Sierra del Castillo Block (Cantera Castillo, El Collado, Navacastillo, Sierra de la Estrella 1 and Sierra de la Estrella 2 outcrops, SCB). The olistoliths in San Antonio-La Juliana Unit constitute the second group that are divided in two sub-groups, the Northern subgroup (Castillo Belmez, Sierra Palacios, El Burjádillo and La Juliana outcrops, NOL) and the Southern subgroup (La Adelfilla and Cerro Cabello outcrops, SOL). The outcrops located at the North-west (NOW), Peñarroya, Fuenteovejuna and El Casar (Table 1, light-grey) are located theoretically within the San Antonio-La Juliana Unit and they could be olistoliths, but they are located between major faults and show assemblages and facies that do not coincide with the olistoliths located to the south-east.

With regard to the coral assemblages, some species are typical from deep-water facies with high input of siliciclastics. Their distribution is related to the environment, and has no biogeographic significance (*Claviphyllum* sp., *Cryptophyllum* sp., *Cyathaxonia cornu*, *Cyathaxonia rushiana*, *Rotiphyllum costatum*, *Rotiphyllum rushianum*, *Rylstonia benecompecta*, *Sochkineophyllum?* sp., *Ufimia bradbournense* and *Zaphrentites delanouei*). In the Guadiato Area they occur when middle or distal platforms are preserved (Couce and Sierra de la Estrella 1). Some other species are widespread in the western Palaeotethys and occur in all units and in most outcrops (*Axophyllum pseudokirsopianum*, *Axophyllum kirsopianum*, *Clisiophyllum garwoodi*, *Lithostrotion*

*decipiens*, *Lithostrotion vorticale*, *Multithecopora* sp. A, *Palaeosmilia murchisoni*, *Siphonodendron martini*, *Siphonodendron pauciradiale*, *Siphonodendron sociale*). They should be discarded from the analysis, but at least two of these species (*Lithostrotion vorticale* and *Siphonodendron sociale*) are absent from the NOW. It means that a certain degree of isolation could affect those outcrops. In the same way, several species occur only in the NOW (*Axophyllum spiralum*, *Axophyllum tazoultense*, *Diphyphyllum gracile*, *Roemeripora* sp.). Some other species are shared only with the outcrops from the SBB (*Amgdalophylloides anticum*, *Axophyllum pseudokirsopianum*, *Morenaphyllum antolinense*, *Multithecopora* sp. B). It indicates a close relationship between those outcrops. It would imply that either the movement of the strike-slip faults was not as important as previously proposed or (more probably) the NOW, limited by faults and surrounded by Cenozoic sediments, are not related with the San Antonio-La Juliana Unit, but with the SBB (Sierra del Castillo Unit). On the other hand, two species (*Axophyllum kirsopianum* and *Gangamophyllum gorskyi*) occur only in the NOW and in the olistoliths (NOL and SOL), indicating a closer relationship of the olistoliths with the northern outcrops from Sierra del Castillo Unit than with the southern outcrops of the same unit, that are today more closely located. In addition to the widespread species, no species are in common between the olistoliths and the SCB. The only two exceptions to this fact are *Siphonodendron kleffense* and *Syringopora* sp. B, that occur in the southern olistolith of Adelfilla and in the Sierra Boyera Block, indicating a closer relationship of the southern part of the San Antonio-La Juliana Unit, with the northern part of the Sierra del Castillo Unit. It would imply that the strike-slip fault between those units displaced relatively those units more than 50 km and possibly more than 100 km. When the localities from the San Antonio-La Juliana Unit are displaced to the north-west, the table with the coral occurrences shows a completely consistent distribution (Table 3).

### 3.4. Biostratigraphy

The coral biostratigraphy from the Guadiato Area was discussed and compared with that from Ireland by Rodríguez & Somerville (2007). Some additional material from El Casar, Fuenteovejuna, Peñarroya, El Cañal, etc. has been studied since then, but no main changes in the biostratigraphy from the upper Viséan from the Guadiato Area can be added here. We identify five biozones. Taking the corals biozones proposed by Mitchell (1989) for Britain and those proposed by Poty *et al.* (2006) as valid references, the zones 1 and 2 would be equivalent to the zone F in Britain and the zone RC6 in Belgium; the zone 3 would be equivalent to the zone RC7 in Belgium and the



**Table 3.** Distribution of taxa in the Guadiato Area outcrops ordered after tectonic rearrangement (possible original position). Note that the random distribution in Table 1 of species with X in bold become coherent in Table 3. Abbreviations same as in Table 1.

| Taxa/Sections                             | NOL             |                 |               | SOL        |              | NOW           |          |               | SBB       |                   |         | C        | SCB           |          |                  |            |              |               |               |
|---|-----------------|-----------------|---------------|------------|--------------|---------------|----------|---------------|-----------|-------------------|---------|----------|---------------|----------|------------------|------------|--------------|---------------|---------------|
|   | Castillo Belmez | Sierra Palacios | El Burjadillo | La Juliana | La Adelfilla | Cerro Cabello | El Casar | Fuenteobejuna | Peñarroya | Casa de la Calera | Antolín | El Cañal | Sierra Boyera | El Couce | Cantera Castillo | El Collado | Navacastillo | S. Estrella 1 | S. Estrella 2 |
| <i>Amplexocarinia</i> sp.                 |                 |                 |               |            |              |               | X        |               | X         |                   |         | X        |               |          |                  |            |              |               |               |
| <i>Amplexus</i> sp.                       |                 |                 |               |            |              |               |          |               |           |                   |         | X        |               |          |                  |            |              |               |               |
| <i>Amygdalophylloides anticuum</i>        |                 |                 |               |            |              |               | X        | X             | X         | X                 |         | X        |               |          |                  |            |              |               |               |
| <i>Amygdalophyllum</i> aff. <i>nexile</i> |                 |                 |               |            |              |               |          |               |           |                   | X       | X        |               |          |                  |            |              |               |               |
| <i>Arachnolasma sinense</i>               |                 |                 |               |            |              |               |          |               |           |                   |         | X        |               |          |                  | X          |              |               |               |
| <i>Auloclisia</i> sp.                     |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          | X                | X          |              | X             |               |
| <i>Aulokoninckophyllum carinatum</i>      |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  |            |              | X             |               |
| <i>Aulophyllum fungites</i>               |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          | X                |            |              |               |               |
| <i>Axoclisia cuspidiforma</i>             |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               |          | X                |            |              |               |               |
| <i>Axophyllum cozari</i>                  |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               |          |                  |            |              |               |               |
| <i>Axophyllum densum</i>                  |                 |                 |               |            |              |               |          |               | X         |                   |         | X        |               |          | X                | X          |              |               |               |
| <i>Axophyllum kirsopianum</i>             | X               | X               |               | X          | X            | X             | X        | X             | X         |                   |         |          |               |          |                  |            |              |               |               |
| <i>Axophyllum mendipense</i>              |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               | X        |                  | X          |              |               |               |
| <i>Axophyllum pseudokirsopianum</i>       |                 |                 |               |            | X            |               |          | X             | X         | X                 | X       | X        |               |          |                  |            |              |               |               |
| <i>Axophyllum spiralum</i>                |                 |                 |               |            |              |               | X        | X             | X         |                   |         |          |               |          |                  |            |              |               |               |
| <i>Axophyllum tazoultense</i>             |                 |                 |               |            |              |               | X        |               |           |                   |         |          |               |          |                  |            |              |               |               |
| <i>Axophyllum vaughani</i>                |                 |                 |               |            |              |               | X        |               | X         |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Caninia</i> sp.                        |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Caninophyllum bechareense</i>          |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               |          |                  |            |              |               |               |
| <i>Cladochonus</i> (TAB)                  |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Claviphyllum</i> sp.                   |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  |            |              | X             |               |
| <i>Clisiophyllum benziregense</i>         |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Clisiophyllum garwoodi</i>             | X               |                 | X             |            | X            |               |          |               | X         | X                 | X       | X        | X             |          | X                | X          |              |               |               |
| <i>Cryptophyllum</i> sp.                  |                 |                 |               |            |              |               |          |               |           |                   |         |          |               | X        |                  |            |              | X             |               |
| <i>Cyathaxonia cornu</i>                  |                 |                 |               |            |              |               |          |               |           |                   |         |          |               | X        |                  |            |              | X             |               |
| <i>Cyathaxonia rushiana</i>               |                 |                 |               |            |              |               |          |               |           |                   |         |          |               | X        |                  |            |              | X             |               |
| <i>Dibunophyllum bipartitum</i>           |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          | X            | X             |               |
| <i>Diphyphyllum furcatum</i>              |                 |                 |               |            |              |               |          |               |           |                   |         | X        |               |          |                  |            |              |               |               |
| <i>Diphyphyllum gracile</i>               |                 |                 |               |            |              |               |          |               | X         |                   |         |          |               |          |                  |            |              |               |               |
| <i>Espielia columellata</i>               |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Gangamophyllum gorskyi</i>             |                 | X               |               |            | X            | X             |          | X             | X         |                   |         |          |               |          |                  |            |              |               |               |
| <i>Gangamophyllum mosquense</i>           |                 |                 |               |            |              |               | X        |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Haplolasma lamelliferum</i>            |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Heterophyllia ornata</i> (HETERO)      |                 |                 |               |            |              |               |          |               |           |                   | X       | X        |               |          |                  | X          |              |               |               |
| <i>Hexaphyllia marginata</i> (HETERO)     |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               |          | X                | X          |              |               |               |
| <i>Koninckophyllum interruptum</i>        |                 |                 |               |            |              |               |          |               |           |                   |         | X        |               |          | X                | X          |              |               |               |
| <i>Lithostrotion araneum</i>              |                 |                 |               |            |              |               |          |               |           |                   | X       | X        |               |          |                  |            |              |               |               |
| <i>Lithostrotion decipiens</i>            |                 |                 |               | X          |              |               |          | X             |           |                   |         |          | X             |          |                  |            |              |               | X             |
| <i>Lithostrotion vorticale</i>            |                 |                 | X             | X          | X            | X             |          |               |           |                   | X       | X        |               |          | X                | X          | X            | X             | X             |
| <i>Morenaphyllum antolinense</i>          |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               |          |                  |            |              |               |               |
| <i>Morenaphyllum boyerense</i>            |                 |                 |               |            |              |               |          |               |           |                   | X       |          |               |          |                  |            |              |               |               |
| <i>Morenaphyllum</i> sp.                  |                 |                 |               |            |              |               |          | X             |           |                   |         |          |               |          |                  |            |              |               |               |
| <i>Multithecopora</i> sp. A (TAB)         |                 |                 |               |            |              |               |          | X             |           |                   | X       | X        |               |          |                  | X          |              | X             |               |
| <i>Multithecopora</i> sp. B (TAB)         |                 |                 |               |            |              |               |          | X             |           |                   | X       | X        |               |          |                  |            |              |               |               |
| <i>Multithecopora</i> sp. C (TAB)         |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  | X          |              |               |               |
| <i>Palaeosmilia murchisoni</i>            | X               |                 |               | X          | X            | X             | X        | X             | X         | X                 |         | X        | X             |          | X                | X          | X            | X             |               |
| <i>Palastraea regia</i>                   |                 |                 |               |            |              |               |          |               |           |                   |         | X        |               |          |                  | X          |              |               |               |
| <i>Pseudozaphrentoides</i> sp.            |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          | X                | X          |              |               |               |
| <i>Roemeripora</i> sp. (TAB)              |                 |                 |               |            |              |               |          | X             |           |                   |         |          |               |          |                  |            |              |               |               |
| <i>Rotiphyllum costatum</i>               |                 |                 |               |            |              |               |          |               |           |                   |         |          |               |          |                  |            |              |               | X             |
| <i>Rotiphyllum rushianum</i>              |                 |                 |               |            |              |               |          |               |           |                   |         |          |               | X        |                  |            |              |               | X             |

|                                    |   |   |   |   |    |   |   |    |    |   |    |    |   |   |    |    |   |    |   |
|------------------------------------|---|---|---|---|----|---|---|----|----|---|----|----|---|---|----|----|---|----|---|
| <i>Rylstonia benecompecta</i>      |   |   |   |   |    |   |   |    |    |   |    |    |   | X |    |    |   | X  |   |
| <i>Siphonodendron intermedium</i>  |   |   |   |   |    |   |   |    |    |   |    |    |   |   | X  | X  |   |    |   |
| <i>Siphonodendron irregulare</i>   |   |   |   |   |    |   | X |    |    |   |    |    |   |   |    | X  |   |    |   |
| <i>Siphonodendron junceum</i>      |   |   |   |   |    |   |   |    |    |   |    |    |   |   | X  | X  |   | X  |   |
| <i>Siphonodendron kleffense</i>    |   |   |   |   | X  |   |   |    |    |   | X  | X  |   |   |    |    |   |    |   |
| <i>Siphonodendron martini</i>      | X |   | X | X | X  |   | X | X  | X  | X | X  | X  | X | X | X  | X  | X | X  |   |
| <i>Siphonodendron pauciradiale</i> |   |   |   | X | X  |   |   | X  |    |   |    |    | X |   |    |    | X | X  |   |
| <i>Siphonodendron scaleberense</i> |   |   |   |   |    |   |   |    |    |   |    | X  |   |   | X  |    | X |    |   |
| <i>Siphonodendron sociale</i>      |   | X |   |   | X  |   |   |    |    | X |    |    |   | X | X  | X  |   |    |   |
| <i>Siphonophyllia samsonensis</i>  |   |   |   |   |    |   |   |    |    | X |    | X  |   | X | X  |    |   |    |   |
| <i>Siphonophyllia siblyi</i>       |   | X |   |   |    |   |   |    |    |   |    |    |   | X | X  |    |   |    |   |
| <i>Sochkineophyllum?</i> sp.       |   |   |   |   |    |   |   |    |    |   |    |    |   |   |    |    |   | X  |   |
| <i>Solenodendron furcatum</i>      |   |   |   |   |    |   | X |    |    |   | X  |    |   | X | X  |    |   |    |   |
| <i>Solenodendron horsfieldi</i>    |   |   |   |   |    |   |   |    |    |   |    |    |   |   | X  |    |   |    |   |
| <i>Syringopora</i> sp. B (TAB)     |   |   |   | X |    |   |   |    |    | X | X  |    |   |   |    |    |   |    |   |
| <i>Tizraia</i> sp.                 |   |   |   |   |    |   |   |    |    |   | X  |    |   |   |    |    |   |    |   |
| <i>Ufimia bradbournensis</i>       |   |   |   |   |    |   |   |    |    |   |    |    | X |   |    |    |   | X  |   |
| <i>Zaphrentites delanouei</i>      |   |   |   |   |    |   |   |    |    |   |    |    |   |   |    |    |   | X  |   |
| Number of recorded species         | 4 | 4 | 3 | 6 | 11 | 4 | 8 | 13 | 14 | 5 | 19 | 23 | 5 | 8 | 17 | 32 | 5 | 19 | 5 |

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